TECHNOLOGICAL HANDBOOKS

SILK DYEING PRINTING AND FINISHING

G. H. HURST F. C. S.

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TECHNOLOGICAL HANDBOOKS.

EDITED BY SIR H. TRUEMAN WOOD,

Secretary of the Society of Arts.

SILK DYEING.

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PRINTING, AND FINISHING.

BY

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PREFACE.

SOME three years ago the publishers of the "Dyer and Calico Printer" asked me to contribute to that journal a series of articles on silk dyeing; this I did, an article appearing in each issue of the "Dyer" for 1889. These attracted some attention at the time, and it was thought desirable to put them in a more permanent and convenient form, the result of which is the following little book.

While the substance of the book consists of the above-mentioned articles, I have rewritten them, and added chapters on Silk Printing and Finishing, and on Testing of Dyed Silks.

I have endeavoured to bring the subject up to date, and the methods of using all the new coal tar colours which have of late years led to new developments in silk dyeing have been included. While aiming to make the book a practical one, I have avoided making it simply a collection of recipes, but have stated the principles of silk dyeing clearly, as I believe a dyer who knows these principles thoroughly can easily apply them practically in producing those innumerable shades and tints which are required. Still, in the body of the book and in the Appendix will be found many practical recipes. By the kindness

of several large firms of coal tar colour makers, I have been enabled to give in the Appendix an extensive series of patterns illustrative of the tints and shades obtainable by the application of many of the newest colouring matters placed on the market; to these have been added a few, specially produced for this work.

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December, 1891.

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SILK DYEING.

CHAPTER I.

SILKS.

SILK is the produce of the caterpillars of various species of moths, natives of India, China and Japan. The species generally known as the silk moth, *Bombyx Mori,* is very largely cultivated not only in its native countries, but also in Southern Europe; and the produce from this moth is specifically known in commerce as "Silk." All other species of silk are denominated "wild silks;" only a few of these are of importance, such as those from the Tussah and Muga silkworms.

Ordinary Silk.—This is produced by the caterpillar of the silk moth (*Bombyx Mori*), fig. 1. This caterpillar or silkworm feeds on the leaves of the mulberry tree, and takes about thirty days to attain maturity, during which period the worm consumes a large quantity of food, casts its skin several times, and after thirty days begins to spin its cocoon, starting from the outside and ending in the inside; in this cocoon it passes its pupa stage. In fig. 1 *a* is the caterpillar; *b,* the pupa; *c,* the female moth; *d,* the

male moth, shown full size. The cocoon, fig. 2, is made up of a single fibre varying from 500 to 1,300 yards in one unbroken length, with an average diameter of one-sevenhundredth of an inch. The cocoons vary in colour from white to yellow. The silk fibre is secreted by a pair of glands situated one on either side of the body below the intestinal canal. Fig. 3 is a diagrammatic sketch of this pair of glands, which consist, first, of two long and much convoluted tubes,

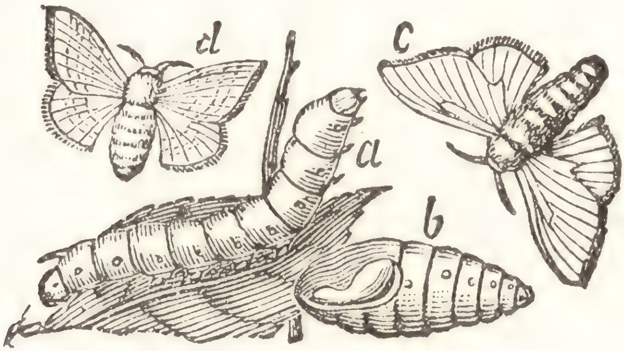


Fig. 1.

1,1, in which the silk substance is secreted; second, of two expanded portions, 2,2, in which the silk secreted in 1,1, is stored; third, of two ducts, 3,3, or seripositors, which unite into one terminal duct, 4, from whence the silk fibre issues from the worm. This double system of secretory glands is the cause of the fibre of silk being formed of two strands, as described on page 5. As long as the silk is contained in these glands, it is liquid, but the moment it issues from the

duct, 4, into the atmosphere, it solidifies into the silk fibre as it is known in commerce.

When the worms have completed the construction of the cocoons the latter are collected; the pupæ or chrysalides contained in them are killed either by heating in an oven or by means of steam: the latter process is preferable as it does less damage to the fibres, and it softens the silk glue, thus rendering the reeling of the silk more easy. At one time it was

Fig. 2.

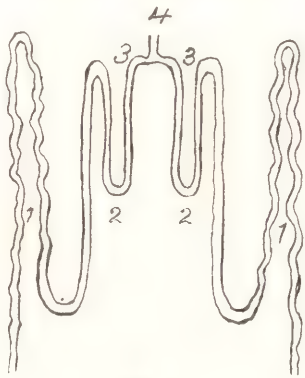


Fig. 3.

considered impossible to reel cocoons from which the moth had escaped, but it is now known that such cocoons can be reeled as easily as others. In the reeling process the cocoons are thrown into a basin of hot soap and water, for the purpose of softening the silk glue which binds the fibres together. The silk reeler takes a short brush and collects the ends of the silk fibre from two or three cocoons, joins these together, and then reels them on the skeleton-wheel of a

reeling machine, thus making them into skeins. Fig. 4 is a drawing of an Italian silk reeling machine. When one cocoon is nearly unwound another takes its place, as the extreme inner ends of the silk fibre are not of good quality. There is always some portion of the outside and inside more or less broken or damaged, which is thrown on one side. The best cocoons are

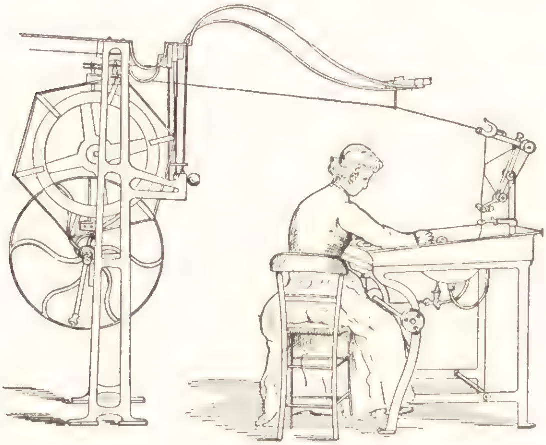


Fig. 4.

kept apart for reeling into what is called *Organzine* silk, which owing to its greater strength is used for the warp of the silk fabrics into which it is woven. The poorer qualities of cocoons are reeled into *tram* silk, which is used for the weft. It is customary always to reel two fibres side by side, and to arrange that the thick portions of one fibre shall be contiguous with the thin portions of the other fibre, so that the

thread of silk shall be nearly uniform in thickness throughout its whole length. The reeled silk is then thrown several threads together to form the various qualities of silk yarns:—Organzine, tram, spun, net, etc., used in silk weaving.

The Silk fibre, when examined under the microscope, is seen to consist of two circular fibres placed side by side longitudinally and firmly united. Occasionally they may be seen apart, but such instances are very rare. This structure of the silk fibre is shown in fig. 5, which is a microscopic sketch magnified about 500 diameters. The double fibre is known in France as the *bave*, and the single fibre as the *brin*, and as there are no corresponding English equivalents we may adopt these terms here. Both are shown in the drawing, and the double structure of the brin is shown in the end sections given. The bave is the fibre as it issues from the silkworm. The fibre is quite devoid of cellular structure, and is nearly homogeneous in appearance. Under polarized light the bave gives a grand display of colour. The brin, or single fibre, is seen to consist of two portions, an inner and an outer, the latter forming from twenty to twenty-five per cent. of the whole; this is about the amount that silk loses in the process of boiling off,

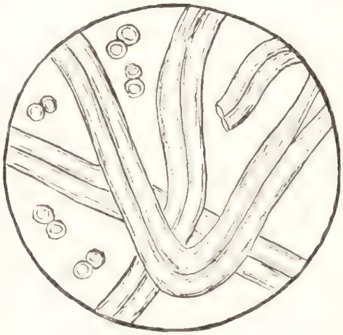


Fig. 5.

and therefore the outer portion of the brin consists of *sericin*, or silk glue (see below), and the inner of *fibroin*, or true silk fibre.

The diameter of each brin averages $\frac{1}{1480}$ of an inch, and that of the bave, or double fibre $\frac{1}{740}$ of an inch, though there is some variation in silks from different countries in this respect. It is very elastic, and is capable of stretching about $\frac{1}{10}$ of its length before breaking: 100 feet will stretch to 113 feet before the limit of elasticity is reached; its breaking strength is about $2\frac{5}{8}$ drams.

Chemical Composition of Silk.—By silk is here meant solely the produce of the mulberry silkworms, *Bombyx Mori*, and other *Bombycidæ.* Tussah and other silks are described further on. Very numerous researches have been made from time to time on the silk fibre by Mulder, Schorlemmer, Bowman, Knecht, and others, which show that in the raw silk fibre, the bave, or more strictly speaking, the brin, is composed of two bodies, first, a substance forming the outer portion of the brin, which is soluble in hot water, and which, owing to its adhesive character, is known as the "gum" in this country, and "grès" in France, its chemical name being *sericin:* second, the silk fibre proper, *fibroin*, forming the central portion of the brin; see fig. 5. Besides these two bodies proper others occur in smaller proportions. Mulder submitted two samples of silk to the successive action of hot water, alcohol, ether, and acetic acid, with the following results:—

	Yellow Italian silk.	White Almasin silk.
Silk fibre (fibroin)	53·35	54·05
Matters soluble in water (sericin)	28·86	28·10
,, ,, alcohol . .	1·48	1·30
,, ,, ether . .	0·01	0·05
,, ,, acetic acid .	16·30	16·50
	100·00	100·00

The bodies thus extracted were subjected to further examination, and Mulder gives these results as the detailed chemical composition of the silk fibre :—

	Yellow Italian silk.	White Almasin silk.
Fibroin	53·37	54·04
Gelatine	20·66	29·08
Albumen	24·43	25·47
Wax	1·39	1·41
Colouring matter . . .	0·05	0·00
Resinous and fatty matter . .	0·10	0·30
	100·00	100·00

The proportion of fibroin here given is probably too low, and the albumen too high, owing to acetic acid having a solvent action on fibroin, and thus the percentage given for albumen must be too high, owing to the altered fibroin it contains. Experiments by other chemists show that about 66 per cent. of fibroin can be obtained from raw silk by treating with solvents. In practice during the boiling off process there is about 30 per cent. of loss.

Fibroin constitutes about 66 per cent. of raw silk. Cramer and Mulder give it the formula $C_{15} H_{23} N_5 O_6$, from which it will be seen that it is a nitrogenous product, and recent researches of Knecht and others show that it is an amido body having both acid and basic properties. It is a silky glistening substance, insoluble in water, but soluble in strong acids, alkalies and a solution of cuprammonium sulphate (Schweitzer's reagent). It is insoluble in ether and alcohol, but is slightly soluble in hot acetic acid. According to Weyl, strong hydrochloric acid converts fibroin into sericin, a body containing 17 per cent. less nitrogen than the former, the nitrogen which is lost being extracted in the form of ammonium chloride.

Sericin or silk glue has the formula $C_{15} H_{25} N_5 O_8$, from which it will be seen that it differs from fibroin in containing less carbon and nitrogen and more oxygen and hydrogen. It is probable that sericin is an altered product of fibroin, inasmuch as it has been noticed that when fibroin has been exposed to the air for some time, the external portion is so altered that it is soluble in water, having been converted into sericin by absorption of oxygen and water, thus:—

$$\underbrace{C_{15} H_{23} N_5 O_6}_{\text{fibroin}} + O + H_2 O = \underbrace{C_{15} H_{25} N_5 O_8}_{\text{sericin}}.$$

Sericin can be obtained in the form of a colourless, odourless, tasteless powder. It swells up in cold water, and is rather more soluble in hot water than ordinary gelatine. Its solution in hot water gelatinizes on cooling, and is precipitated from its aqueous solutions by alcohol, tannic acid and solutions of metallic salts.

When boiled for some considerable time with water, raw silk loses its gum but not the fatty or other matter it contains, and the tenacity of the fibre is somewhat reduced. All hot liquids exert a similar solvent action on the gum, and for this reason it is necessary to carry on any mordanting or dyeing operations at as low a temperature as possible.

Dilute mineral acids have no appreciable action on silk, but they have the property of imparting to it a peculiar "scroop" or crackle, the cause of which has not been ascertained. Strong mineral acids rapidly destroy silk; sulphuric acid reduces it to a brown solution, from which, when diluted with water, the fibroin can be precipitated by tannic acid. Nitric acid also destroys silk, but moderately dilute nitric acid gives it a yellow colour, due to the production of xanthoproteic acid, the silk being considerably weakened by the operation. This reaction with nitric acid can be used to distinguish silk from cotton. Hydrochloric acid dissolves silk even when used cold.

Sulphurous acid, either in a solution or as gas, destroys the colour of raw silk, and is therefore of use in bleaching silk.

Organic acids when used in the form of hot dilute solutions, simply remove the sericin, and have very little action on the fibroin; weak solutions of such acids as acetic, tartaric, and oxalic are largely used for restoring the lustre of silk after it has been boiled in soap, or dyed; this is the basis of the brightening operation.

Strong solutions of the caustic alkalies, potash or soda, completely and rapidly dissolve silk, especially

if applied warm; very weak solutions simply remove the sericin or gum from raw silk, and although they have no appreciable solvent action on the silk fibre, yet they destroy its brilliancy or lustre, and more or less affect its colour, hence the use of the caustic alkalies in the treatment of raw silk is quite inadmissible. The carbonates of potash and soda act in a similar manner, completely dissolving the silk when used strong, but when weak their action is not so energetic, and is therefore more under control, though their use is not advisable on account of the risk run of damaging the silk fibre. Soap is almost the only alkaline substance that can be safely used for "boiling off" or "degumming" silk. Hot soap solutions readily and completely remove the gum and leave the fibroin lustrous, elastic, and strong. Being cheap and easily obtainable, soap is the degumming agent usually applied in all silk works.

Borax is a weak alkaline salt that has no action on silk but while very useful as a mordant for some colours that require an alkaline bath, it is not useful as a degumming agent.

Lime water first causes the silk to swell, if the latter be steeped in it, and has an apparently softening action on the silk gum; if, however, the action of the lime water be too prolonged, the silk fibre has a tendency to become brittle.

Potassium permanganate has an energetic action on silk, oxidizing it and causing it to turn brown, a deposit of hydrated oxide of manganese being formed on the silk. On steeping the discoloured silk in a solution of sulphurous acid, the brown colour is dis-

charged, leaving the silk beautifully white and lustrous. A process for bleaching silk, based on this reaction, has been devised, and used on a large scale with some success; it has been found, however, that the silk has a tendency to acquire a yellowish tint after a time, or on boiling with soap or weak alkalies. The bath of permanganate must not be too strong, nor must the silk be immersed for too long a period, or the oxidation of the silk will proceed too far, the fibre be too much attacked, and its strength deteriorated.

If silk be allowed to steep in a solution of potassium bichromate, it is slowly oxidized, the silk acquiring an olive green tint due to the formation and deposition of chromium oxide in the fibre. This is useful in mordanting silk which is to be dyed with the alizarine dyes. The action of the salt is not very great, silk differing from wool in this respect; on this account bichromate is rarely used as a mordant for silk dyeing.

Silk, when immersed in neutral or basic solutions of many metallic salts, such as alum, sulphate of alumina, nitrate of iron, chloride of tin, acetates of iron, alumina, lead and chromium, etc., has the peculiar property of attracting to itself the oxides of the metals. This property is a very valuable one and much used in mordanting silk for blacks and those colours which require a mordant. In some cases, as in those of nitrate of iron and perchloride of iron, the quantity of oxide absorbed from the solutions greatly increases the weight of the silk, a property not lost sight of by silk dyers.

Silk is soluble in strong solutions of chloride of

zinc, from which it is thrown down as a precipitate on diluting the solution with water. It is also soluble in strong solutions of stannic chloride, 70° Tw., in an ammoniacal solution of copper, in an alkaline solution of copper sulphate and glycerine, this property serves to distinguish silk from wool and cotton, on which the solution has no action. The solution is made as follows:—Dissolve 16 grammes copper sulphate in 150 cc. water, add 10 grammes of pure glycerine, then add a solution of caustic soda until the precipitate which first forms is just dissolved; much excess of caustic soda is to be avoided.

Silk has the property of absorbing from the atmosphere a large quantity of moisture—from 25 to 30 per cent. of its weight—without any change in its appearance. As silk is very costly, it is worth while for a seller to keep his silk in a damp room before sending it out. On the Continent the silk centres have conditioning establishments, where silk is regularly conditioned for the amount of water it contains; it has been agreed that silk should be considered to contain normally 11 per cent. of water, and raw silk is always bought and sold on this understanding. See also Chapter VIII., "Assaying of Silk."

Wild Silks.

Under the generic name of "wild silks" there comes into the market, chiefly from India, in a more or less fitful manner, quantities of silk derived from species of silk moths other than *Bombyx*, of which the most

important are Tussah, from *Antherea mylitta;* Eria, from *Attacus ricini;* Ailanthus, from *Attacus synthia;* Muga, from *Antherea Assama;* Selene, from *Actias*

Fig. 6.

Fig. 7.

Selene; Atlas, from *Attacus Atlas;* Yama Mai, from *Antherea Yama Mai.*

Tussah or Tussur silk forms the great bulk of the so-called "wild silk" which is imported into this country from India, and it is sent over in fairly large

quantities. It is the product of the Tussah silk-moth (*Antheraea mylitta*), figs. 6 and 7, showing respectively the male and female of this moth, which is found in all parts of India in large numbers. The cocoons are large, and have a peculiar shape, fig. 8, and the silk has a characteristic drab colour and strong odour.

Tussah silk differs from mulberry silk in several important features. In the first place the fibre of the silk is longer, usually averaging 600 to 2,000 yards in length; it is thicker, the average diameter being $\frac{1}{600}$ to $\frac{1}{700}$th of an inch, and the bave is composed of a large number of fibrets, having a diameter of from $\frac{1}{2500}$ to $\frac{1}{8000}$ of an inch, which gives the fibre a peculiar striated appearance. Fig. 9 is a drawing of the Tussah silk fibre as seen under the microscope. The bave is more or less of a flat or ribbon form, and is frequently twisted as shown in the drawing; in this respect it resembles cotton. The number of fibrets show that the silk-secreting organs of the Tussah caterpillar are more complicated than those of the *Bombyx* moths. Further, in mulberry silk, any colour that particular varieties of silk may possess is entirely in the gum, the fibroin

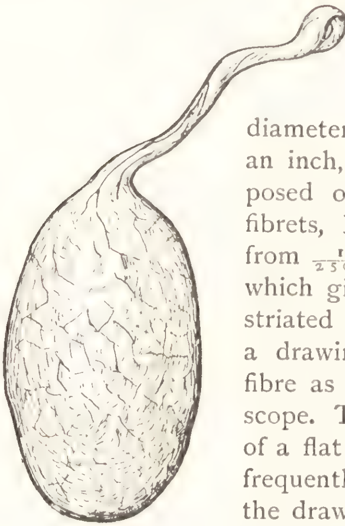


Fig. 8.

being quite white; the colour of Tussah silk permeates the fibre, thus making it very difficult to bleach.

The *Chemical Composition* of Tussah silk has not been thoroughly investigated, and there is room for further research on this point. The latest investigations are those of Dr. Knecht,[1] who found that boiling in water removed 21·33 per cent. of sericin, etc.; there was 0·91 per cent. of fatty matter and 0·08 per cent. of wax. On boiling in soap and water the sample lost 26·49 per cent. The fibroin was examined, and found to have the following composition:—

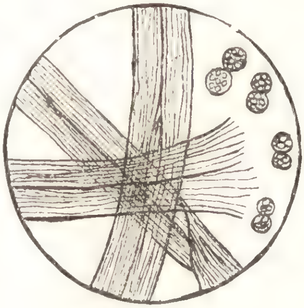


Fig. 9.

Carbon	47·18	per cent.
Hydrogen . . .	6·30	„
Nitrogen . . .	16·85	„
Oxygen	29·67	„
	100·00	„

Tussah silk fibroin contains more oxygen, less carbon, and less nitrogen than silk fibroin, and has the formula $C_{15} H_{27} N_5 O_7$. Tussah silk differs from ordinary silk in the following ways: it is not so soluble in solutions of caustic soda, and is only partially soluble in strong hydrochloric acid, while ordinary

[1] "Journal Socy. Dyers and Colourists," 1888, vol. iv. p. 88

silk dissolves immediately; nitric acid dissolves it to a brown solution; zinc chloride of 142° Tw. dissolves ordinary silk immediately, whilst it dissolves Tussah silk slowly. This is also the case with a solution of chromic acid. It is evident that Tussah silk fibroin is distinct from ordinary silk fibroin, both in its composition and its properties. It is more difficult to

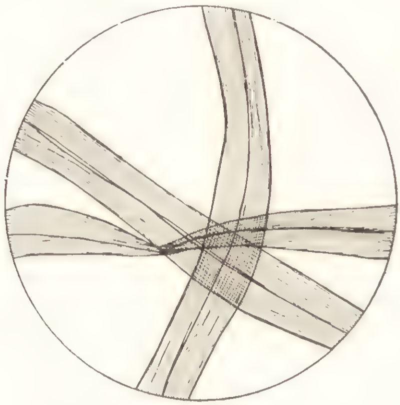


Fig. 10.

bleach, and its affinity for dyes does not seem to be so great.

Although India has a large number of silk-producing moths, very few are of any commercial importance; some, such as Eria silk from *Attacus ricini*, Muga silk from *Antheraea Assama*, are somewhat largely used in the locality where they flourish, yet rarely come into English commerce, probably because the collection of the cocoons is not carried on systematically. It is

only necessary, therefore, to refer to these wild silks very briefly; for further details, Wardle's "Handbook on the Wild Silks of India" may be consulted.

Eria Silk.—This comes from the moth, *Attacus ricini*, which is found mostly in Nepaul, Assam, and the neighbouring provinces; it feeds principally on the castor oil plant (*Ricinus communis*); it is rather

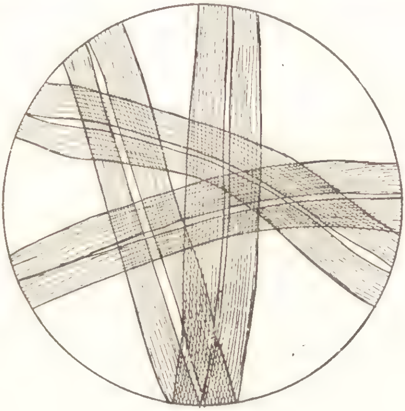


Fig. 11.

large, the female being the larger, and more rounded in the body; probably it could be cultivated wherever the castor oil plant can be grown. The chemical composition and properties of Eria silk have not yet been properly investigated; in its structure it resembles that of Tussah silk, the single fibre or brin being made up of fibrets. It is, therefore, reasonable to suspect that it will not differ much from Tussah silk in its properties, and in the methods to be used in

bleaching and dyeing it. Fig. 10 is a drawing made with the microscope.

Muga Silk.—This variety of silk comes from the Muga moth (*Antherea Assama*), which belongs to the same family as the Tussah moth. It is found, as its specific name indicates, chiefly in Assam, and also in a small district in Dehra Dun, west of Nepaul, and in

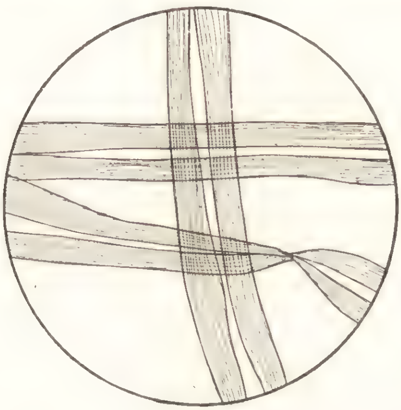


Fig. 12.

Dhurumpoor in Bombay; it feeds on the leaves of the *soom* tree (*Machilus odoratissima*); it is a large moth, the female being much larger than the male, and very handsomely marked. The silk of the Muga worm very closely resembles Tussah silk in its structure (see Fig. 11), and there is scarcely any doubt that its properties are very similar, though no direct investigations have yet been made on it.

Atlas Silk.—This is the product of the Atlas moth

(*Attacus Atlas*), which is found abundantly in South India, in several districts in North India, in Ceylon, etc. The Atlas moth is the largest of the silk-moths, measuring from 7 to 8 inches from tip to tip of wings. Like the two wild silks just described, it is used only locally, and that only to a limited extent. From Fig. 12 it will be seen that it resembles Tussah in its structure.

The other wild silks are of comparatively small importance, and do not need description here.

The following table shows the comparative sizes and strengths of various silks :—

Table of diameter, length, strength, elasticity of Silks.

Silk.	Diameter of fibre (bave) in inches.	Elasticity or stretch of silk one foot in length.	Breaking weight, drams avoirdupois.	Length of fibre.
Mulberry (*Bombyx Mori*) .	$\frac{1}{1650}$	1·6	$2\frac{1}{2}$	400 to 800 yds.
Tussah (*Antherea mylitta*)	$\frac{1}{600}$	2·3	$7\frac{1}{8}$	600 „ 2,000 „
Eria (*Attacus ricini*) . .	$\frac{1}{1100}$	1·8	$2\frac{1}{4}$	
Muga (*Antherea Assama*) .	$\frac{1}{790}$	2·6	$3\frac{3}{4}$	
Atlas (*Attacus Atlas*) . .	$\frac{1}{940}$	2·3	$3\frac{1}{8}$	
Ailanthus (*Attacus Cynthia*)	$\frac{1}{1115}$	2·7	$2\frac{3}{4}$	
Yama Mai (*Antherea Yama Mai*)	$\frac{1}{1080}$	3·0	$7\frac{1}{8}$	
Attacus Selene	$\frac{1}{960}$	2·4	$3\frac{1}{8}$	
Antherea Pernyi	$\frac{1}{740}$	2·3	$4\frac{1}{2}$	

CHAPTER II.

BOILING OFF AND BLEACHING OF SILK.

a. Bombyx or Ordinary Silk.

RAW silk generally contains a little colouring matter, although there are some varieties of Bombyx silk which come into the market having a considerable amount of colour (usually yellow). This colour in Bombyx silk exists almost entirely in the gum, and the removal of this by processes which are detailed below is generally sufficient to eliminate the colour and leave the silk fibre a good white. The general name given to such scouring processes is that of "boiling off." Sometimes the "boiling off" does not entirely eliminate the colour, and in such cases when it is desired to have the silk fibre quite white it is subsequently subjected to the action of bleaching agents, usually burning sulphur, sulphurous acid, alkaline acid-sulphites, or hydrogen peroxide.

The "boiling off" process comprises several operations, and according to the manner in which it is performed, the several varieties of treated silks are distinguished in the silk trade. There are three principal varieties of such scoured silks, known as *Boiled off silk*, in which all the gum has been removed;

Souple silk, which has been so treated that a portion only (about one-sixth) of the gum has been removed; and *Ecru silk*, which has been subjected to such gentle treatment that only about one-twelfth of the gum has been removed.

"*Boiled off*" *silk* is prepared by several processes, each of which consists of a number of operations, which have as their object the complete removal of the gum and colouring matter of the silk. The ordinary process of "boiling off" silk is carried out usually in about three operations known as, 1st, Stripping, or ungumming (French, *dégommage*); 2nd, Boiling off (French, *La cuite*); 3rd, Bleaching.

1st. *Stripping*. In this operation the great bulk of the gum is removed, and with it most, if not all, the colouring matter present. The operation is known in France as *Dégommage*, and in this country as "ungumming." The operation is generally carried out in rectangular wooden vats measuring 10 feet by 3 with a depth of 3 feet; such a vat will hold about 80 lbs. of silk; a steam-pipe running round the bottom serves to heat up the contents of the vat. The skeins of silk are hung in this vat from wooden rods resting on the sides. If only small quantities of silk are to be treated, proportionately smaller vessels may be used; in some works the vats are made of iron or of copper, but wood offers less risk of metallic stains, which are not easily got out of the silk. Sufficient water is used to allow the skeins to hang freely, not less than 3 gallons to 10 lbs. silk, but more, if possible; 3 lbs. of good olive oil soap is dissolved in it for every 10 lbs. of silk; and its temperature is raised to about

190° to 195° F. The silk is immersed and worked in it from half an hour to an hour, while the heat may be raised to 203° or 205° F. At first the silk swells up and becomes sticky, but after it has been in the bath about five minutes the gum begins to dissolve and leaves the fibre glossy. At the end of the operation the hanks are taken out, squeezed, and then rinsed in water containing about $\frac{1}{4}$ lb. soap and 2 oz. soda to the gallon.

If the silk is required to be very white, or is being prepared for pale dyes, then it is desirable and even necessary to use 2 or even 3 soap baths. The first soap bath contains $2\frac{1}{2}$ lbs. of soap for every 10 lbs. of silk, and is used as above; the second bath contains $1\frac{1}{2}$ lb. of soap for every 10 lbs. of silk. The third soap bath, when used, may contain only 1 lb. of soap to 10 lbs. of silk. The last soap bath may, by adding $\frac{1}{2}$ lb. more soap, be used as the second soap bath for a new lot of silk, and similarly the addition of 1 lb. more soap to the second renders it usable for a new batch of silk. This plan of working not only leads to better results but economizes soap. Experience is required for the due carrying out of this work, and it is in such cases where the material operated on is variable in character, that the practical man is enabled by his experience to stop the process when the desired effect has been obtained, for which no definite rules can be laid down in books; the treatment in the soap baths should continue only just long enough to get the gum off; if further prolonged the fibroin will begin to take up colour from the bath, which it is difficult to remove afterwards.

If the water is at all calcareous a quantity of insoluble lime soap will form in the bath, and if this is thrown down on the silk may prevent its proper stripping; this fault may be cured by adding a little soda before making up the bath.

Silk which has been weighted in the gum gives a great deal of trouble in the stripping bath, as the metallic bodies with which it has been weighted combine with the soap and form insoluble soaps, which are deposited on the silk; causing it to be tarnished and sticky, and making the ungumming extremely difficult, if not impossible. These weighted silks should be treated by rinsing in water, then soaking in a warm bath at 100° to 120° F. of dilute hydrochloric acid—one of acid to one of water—which will as a rule remove the great bulk of the weighty matter. After steeping in the acid for about two hours they are taken out and rinsed in clean water, when they are ready for the stripping baths.

The soap baths after use are known as "boiled off liquor," and are kept for use in dyeing silk, although I think that boiled off liquor is used in dyeing with the coal tar colours oftener than is necessary, especially where acid colours are used.

Boiled off liquor is usually of a faint brownish colour, rather glairy in appearance, has a gravity of about 1·010 to 1·006 (2 to 1½ deg. Tw.) and contains from 1,250 to 1,300 grains of solid matter per gallon, of which some 900 to 950 grains (2 to 2½ ozs.) are soap. A sample which the author examined contained 1,260 grains per gallon, 135 grains of soda (Na_2O) equal to about 944 grains of soap. A good deal of the "boiled

off" and other soapy liquors from silk scouring and dyeing find their way into the nearest brook or river, thus polluting it to a very considerable extent. In view of the possibility of legislation compelling manufacturers to turn out the waste waters in a state of purity it behoves silk dyers and scourers to turn their attention to the recovery of the soap from their waste liquors.

A good method is to collect the liquors in wooden tanks, heat up to about 150° F., and run in sufficient lime-water to precipitate all the soapy matter as an insoluble lime-soap, which is collected by filtering, treated with just enough hydrochloric acid to decompose it, and the mass heated to melt the fat into one mass on the top of the liquor; this fat is then separated, and can be converted into soap by the addition of sufficient alkali.

Another more expensive and complicated plan, is to evaporate the liquors down in a multiple evaporating system (see "Chemical Trade Journal," January 3rd, 1890); the water which distils over could be used for making new bleaching and dye-vats, and, being pure, would answer better than ordinary water; it could also be used with advantage in the ordinary steam-boilers, inasmuch as it would leave no scale. The concentrated liquor is treated with lime as before. The liquors from the lime-soap still contain the silk gum or sericin; and as this body has no technical uses, it would not pay to recover it, yet it is not desirable to send it into the watercourses because of its decomposable character; perhaps the best plan, which would pay in the end, would be to concentrate

these liquors to complete dryness on the Porion Evaporator, and so recover the alkali they contain. Care must, however, be taken to add only sufficient lime to precipitate out the soap, so that no lime is left in the recovered alkali from the Evaporator. This alkali can be used for making fresh batches of soap. By such means organic matter is kept out of the watercourses; the only waste liquor is what is formed on treatment of the lime-soap with acid to recover the fat, and it may be run away into the watercourses without fear of polluting them. These methods are merely suggestions as to what may be done with these waste liquors. They may not be applicable in every case, but a scientific opinion would soon put the silk-bleacher and dyer on the right track.

2nd. *Boiling off.*—After the stripping, the next operation is the boiling off (French, *La cuite*). The stripped silk from the last operation is put into bags made of hemp or flax, which are generally known as "pockets" by silk-dyers; these are put into boiling vats or kettles, constructed of copper or other suitable material, and boiled for half-an-hour with 10 per cent. of soap, after which the silk is well washed with clean water. Should this contain much calcareous matter, it is advisable to add a little sodium carbonate, to prevent the deposition of any insoluble lime-soap on the silk.

It is not necessary to put the silk into bags; very often it is hung on wooden rods in the soaping vat. The soap liquors left in the vats can be used to strip a fresh lot of raw silk, thus saving soap; these liquors are used as "boiled off" liquors for dyeing.

The quality of the soap used for the stripping and boiling off is of some importance, and care must be exercised in selecting it. If the silk is to be dyed in pale colours or left white, then only the best oil-soaps should be used, such as are white and free from any unpleasant odour. Perfumed soaps should be avoided. Olive oil and cocoanut oil soaps can be recommended; the latter can be used with very hard water, as it is much more soluble in water than any other kind of soap, but it frequently contains much water, which it is not easy to detect from the outward appearance of the soap. Castor oil soap is also very soluble, and is a good cleanser, but the odour of the oil is apt to be too persistent for whites or pale tints. Good white tallow-soap is excellent for this purpose. For black and sad colours, such as browns, etc., where the silk passes through many baths, the poorer qualities of soap will do equally well, as any unpleasant odour disappears during the process of dyeing, as well as any colour the soap may impart to the silk. Soaps made from oleic acid, palm oil or poor tállow, can be used for dark colours.

3rd. *Bleaching.*—If the silk is to remain white, or to be dyed in pale tints, it has to be bleached after passing through the boiling off baths. Only one of the many processes will be described here, but further on descriptions of other methods will be detailed.

Bleaching by sulphur.—The silk is hung in closed chambers, so that it can be stoved with sulphur. It is most desirable that these chambers should be divided in two by a perforated false bottom; in the upper part the skeins of silk are hung on wooden

rods, in the bottom portion sulphur is burnt. After the chamber has been filled not too tightly with silk, the doors are closed, and a quantity of sulphur placed in an iron pan is burnt under the perforated plate, generally 1 lb. of sulphur is allowed to from 25 to 30 lbs. of silk; the latter is allowed to hang from 4 to 6 hours, when it is taken out, and well rinsed in water. If the silk is not white enough the stoving is repeated. Stoving with sulphur is a very unpleasant operation, as the sulphur dioxide gas has a suffocating effect when breathed by the operatives. It has a deteriorating action on the metal-work of the stove, and the bleach is not permanent, for on treating the silk with soap or alkalies its original tint is restored. These defects are lessened by the use of alkaline sulphites, and entirely avoided by using peroxide of hydrogen. The methods here indicated are detailed below.

Souple silk is silk from which only part of the gum has been removed, and which has been treated specially to leave it soft and pliable. There are four operations: 1st, scouring; 2nd, bleaching; 3rd, sulphuring; 4th, softening.

1st. *Scouring.*—The object of the operation is to remove the grease and a part of the gum. It is usually accomplished by treating the silk for 1 or 2 hours in a bath of 10 per cent. of soap at from 85 to 95° F., after which it is squeezed. This removes the grease and a little of the gum, while it causes the fibres to swell, and so opens the pores, making it capable of absorbing other materials more readily.

2nd. *Bleaching.*—In this case the operation is done

with a mixture of 1 part of nitric acid and 5 parts of hydrochloric acid diluted with water to 5° or 6° Tw.; usually 1 of mixed acids to 15 of water is used. In this weak acid the silk is steeped for about 15 minutes, not longer, as the silk is liable to become yellow by the action of the nitric acid. After this acid treatment it is well washed in clean water and wrung out, when it is ready for the next operation of sulphuring.

3rd. *Sulphuring* is done in the same way as previously described, after which the silk usually has a hard rough feel, which is removed by the next operation.

4th. *Softening.*—French, *assouplage.* The silk is boiled in a weak bath of cream of tartar, $\frac{3}{8}$ lb. of tartar in 10 gallons of water from 1 to $1\frac{1}{2}$ hours; wrung out and dried. The action of the tartar is somewhat uncertain; other bodies have been tried, Epsom salts, Glauber's salts, with more or less success, but none are as good as tartar.

Ecru Silk is white silk, from which only a small portion of the gum, but almost the whole of the colouring matter, has been removed. For ordinary Ecru silk the process is usually as follows: 1st. Washing in cold water; 2nd. Washing in 10 per cent. of soap at 80 to 90° F.; 3rd. Sulphuring; 4th. Bleaching; 5th. Washing; 6th. Sulphuring. If a very white Ecru silk is wanted, then the following series of operations are employed: 1st. Cold soap 10 per cent.; 2nd. Washing; 3rd. Sulphuring; 4th. Bleaching; 5th. Washing; 6th. Soaping with 10 per cent. of soap at 80 to 90° F.; 7th. Sulphuring; 8th. Washing; 9th. Treating with cold weak (1·5 per cent.) soda; 10th. Treating with warm

weak (3 per cent.) soap; 11th. Washing; 12th. Sulphuring; 13th. Washing. These operations resemble those already described.

Chappe Silk is usually only treated to the stripping bath described above.

Spun Silks, Embroidery Silks, and twisted or corded silks require longer boiling than thrown silks; it usually takes from 1½ to 2 hours' boiling to remove the gum completely.

Stripping or Degumming by Steam.—A process of degumming silk by steam, first described by Samuel Brierley in an English patent (No. 4628), 1821, and more recently favourably spoken of by a writer in "Romen's Journal," 1890. The skeins of silk are hung on wooden rods in a strong soap (30 per cent.) bath at a temperature of 145 to 150° F., being turned until they are thoroughly wet. They are then hung in a large box which can be closed hermetically. In this they are steamed for 20 to 30 minutes, at a pressure of 7½ lbs. The silk gum dissolves, and flows off the silk into a cavity at the bottom of the steaming-box. The silk is next boiled in weak soap for 20 minutes to remove whatever sericin may be left in it, after which it is well washed in water, wrung, and dried. It is thought that by this process there is a saving of soap, and that a better white is obtained because any dirt, colouring matter, etc., flows away with the sericin to the bottom of the steaming-box.

Bleaching Silk.

Often silk, after it has been boiled off, retains a faint yellow tint, which can be removed in several ways:

1st. By sulphuring or stoving; 2nd. Bleaching by Peroxide of Hydrogen; 3rd. Bleaching by Alkaline Bisulphites; 3rd. By Tinting.

1st. *By Sulphuring.*—The manner of carrying out this method has already been described (p. 26), and the objections to it pointed out.

2nd. *By Peroxide of Hydrogen.*—This substance is unquestionably *the* bleaching agent for silk and animal fibres. It is a colourless liquid, clear, limpid, without odour and taste, is sold of various strengths, as 10-volume, 20-volume, and so on, which means that when treated with potassium permanganate it gives off so many—10, 20, etc.—times its own volume of oxygen. It has never been obtained chemically pure, corresponding to the formula $H_2 O_2$ which is given to it, but always in the form of solution. As a rule the commercial product is free from impurities. The method of using it is comparatively simple; the commercial article is diluted with water; the silk which has been freed from grease, etc., by boiling in soap is placed in the bath, and left there until it is bleached, then it is taken out, washed, and dried. For 10 lbs. of silk a bath may be made up with 46 gallons of water, 2 gallons of peroxide of hydrogen (10-vol.), and a little liquor ammonia or borax. The silk is entered into this, and allowed to remain 12 hours; then it is turned over, and allowed to remain another 12 hours, after which it is heated to 120° F. from 2 to 3 hours. If necessary, this process may be repeated until the desired whiteness has been attained. It is found that the bath is more stable when it is slightly alkaline, and is, therefore, more economical in use.

Other methods of using peroxide of hydrogen will be found under BLEACHING OF TUSSAH SILK.

3rd. *Bleaching by Alkaline Bisulphites.*—Lately a method of bleaching by the use of alkaline bisulphites has been described as follows:—Into a tank of a capacity of 110 gallons is placed 66 gallons of bisulphite of soda of about 75 to 80° Tw., with sufficient zinc powder; after being thoroughly stirred up for 1 hour, it is allowed to settle for 12 hours. By the action of the zinc on the bisulphite of soda, hydrosulphite of soda and sulphites of soda and zinc are formed thus:

$$\underset{\text{Sodium bisulphite.}}{3NaHSO_3} + \underset{\text{Zinc.}}{Zn} = \underset{\text{Sodium hydrosulphite.}}{NaHSO_2} + \underset{\text{Zinc sulphite.}}{ZnSO_3} + \underset{\text{Sodium sulphite.}}{Na_2SO_3} + \underset{\text{Water.}}{H_2O}.$$

The zinc and sodium sulphites crystallize out, and are separated from the liquor; this is kept as free from air as possible, to prevent oxidation to bisulphite. The bleaching is done in a separate tank, one volume of the liquor is mixed with one volume of water to form the bleaching bath, the silk which has been soaped to remove grease, dirt, etc., is placed in this, and allowed to remain in it for 6 hours; it is then rinsed well in clean water, placed in a bath of weak hydrochloric acid, and again well washed. If not white enough, the process can be repeated. It is said the process gives very good results, but the author has had no practical experience of it.

Professor Lunge writes favourably of a combination process of the sulphur and hydrogen peroxide methods; the silk is first sulphured or bleached with bisulphite, then it is put in a bath made of 7 gallons water, 1½ gallons peroxide and hydrogen, and 1½ lb. silicate of soda for a few hours. This bath converts any sulphurous acid left in the silk into sulphuric acid, which can be washed away.

By Tinting.—This method is often called, especially on the Continent, "white dyeing of silk." The silk as it leaves the boiling-off process, has a faint yellowish tinge, which can be removed by tinting the silk with a little blue colouring matter, the two complementary colours neutralizing one another. The process consists in simply immersing the silk in a bath of water containing a little methyl violet, indigo extract, or some other blue dyestuff; care must be taken not to add too much, or the silk will be tinted blue instead of white. Experience must be the guide of the dyer in these cases.

b. Boiling off and Bleaching of Wild Silks.

Wild Silks differ from mulberry silk in one important particular, they are more or less coloured, and this colour is distributed through the fibre, and is not on its surface as in the case of the cultivated silk. Consequently the process which is capable of giving a good white with the latter fails with the wild silks. This has been a great drawback to the use of wild silks, more especially with Tussah silk, which can be got in such large quantities; however, all these difficul-

ties are now got rid of by the use of hydrogen peroxide.

There are many processes for bleaching Tussah silk, but they are simply modifications of one main process. One great difficulty is the existence of a small quantity of lime in Tussah silk, which acts injuriously in the ordinary boiling off process. A good method of boiling off and bleaching Tussah and other wild silks is the following:—

1st. Treat the silk with dilute hydrochloric acid, 1 acid to 6 water, for about two hours, to remove lime, afterwards wash thoroughly. This is beneficial in other ways than simply removing the lime: it clears away a good deal of dirt, gum, colouring matter as well, thus tending to keep the soap-bath cleaner.

2nd. Boil in 20 per cent. of soft soap, or 5 per cent. of soda for 1 hour; wash well.

3rd. Steeping for 24 hours in a weak, 1° Tw., bath of hypochlorite of ammonia. This latter body is made by mixing solutions of bleaching powder and carbonate of ammonia together, allowing this to settle, and using the clear liquor. After being steeped in this, the silk is treated to—

4th, a weak bath, 2° Tw., of hydrochloric acid for 20 to 30 minutes, after which it is well washed, then entered into—

5th, a bath of peroxide of hydrogen, made as described on page 30, in this it is left for 24 hours, after which it is well washed. It should now be thoroughly bleached, but if not white enough the peroxide bath may be repeated.

Kœchlin gives the following process for bleaching

Tussah silk: Prepare a bath with 22 gallons of water, 22 lbs. caustic soda, 66 lbs. soap, 11 lbs. calcined magnesia, 11 gallons hydrogen peroxide, 10 vol., and a little ammonia. The silk is steeped in this, or, better still, boiled in it for a few hours. He states that the results are excellent.

A good method is, 1st, boil in clean water for ½ an hour, wring out; 2nd, boil in 30 per cent. soap, or 10 per cent. soda crystals for ½ to 1 hour, wash in warm water, then steep in a bleaching bath made of 40 gallons of water, 2 gallons peroxide of hydrogen, and a little ammonia, for 10 to 12 hours, repeat if necessary, finally well wash the silk.

Another plan is to combine both the sulphurous and the peroxide methods as described on page 32.

CHAPTER III.

DYEING BLACKS ON SILK.

DYEING Black on Silk is unquestionably the most important branch of silk dyeing, and it has probably received more attention than any other branch, and in consequence has been brought to a high degree of perfection. Blacks on silk are produced both from natural and artificial colouring matters, the former having retained their pre-eminence; for various reasons the artificial coal-tar blacks have not yet been able to displace them. We may group these blacks into three divisions, 1st, Logwood blacks; 2nd, Tannic blacks; 3rd, Coal-tar blacks.

1st, *Logwood Blacks.*—These form the staple of the black silk dyer, who has carried their production to a high degree of excellence; but, unfortunately, besides aiming at a high state of perfection in the actual dyeing operation, the black silk dyer has also aimed at increasing the weight of the dyed silk, so that it is possible for him to receive 1 cwt. of raw silk and to send out 5 cwt. (!) of black silk, the extra 4 cwt. being additions made in the process of dyeing. This weighting of silk is a matter, in my opinion, to be fought against, but I am afraid it will require a good deal of

opposition, for the buyer, who cannot of course know what he or she is buying, will very frequently prefer an apparently cheap, heavy weighted silk to a (comparatively) dear but pure silk which would wear longer, and therefore in the end be cheaper. Heavily weighted black silks are very brittle and liable to crack, especially if kept folded; many people view black silk with disfavour for this very reason, and though they know that good serviceable black silk can still be obtained, yet because of their inability to tell good from bad, ladies do not buy as many black silk dresses now as formerly.

Logwood black silk dyeing consists essentially of alternate treatments in separate baths with the mordants and dye stuffs suitable for producing the desired colour and weight. The number of treatments and the length of time taken in each operation depends upon the intensity of the black, and the amount of weighting which is desired to be attained. As the details of the operations are practically the same for all kinds of logwood blacks, the method of producing a heavy black will be described in detail, and the other varieties of blacks will only be mentioned in outline.

Heavy Black (100 *per cent.*) *on Silk.*—This is done as follows:—

1st. Boil off the silk as has been previously described. Page 20, *et seq.*

2nd. *Mordanting.*—This is done in a bath of nitrate of iron. The sulphate variety is the best to use, that made directly from iron and nitric acid does not give as good results for some reason or other. A bath of the nitrate is made of a strength of 40° Tw., into

which is placed the skeins of silk, and they are well turned over in it for one hour in the cold; they are then taken out, all surplus liquor wrung out, the silk rinsed with water, and put back into the bath, and the turning, wringing, and rinsing is repeated. The silk has gained in weight by this operation, by having absorbed a quantity of oxide of iron from the bath. After the silk has been worked in the iron bath three or four times, the process is somewhat modified to insure the silk gaining weight. This consists in, after taking the silk out of the iron bath and wringing, dipping it in an old soap bath, or in a bath of "boiled off" liquor for about ¼ hour. A bath of soda crystals may be used instead of the soap with good results. It is repeatedly wrung out and reimmersed in the iron and soap baths which causes a deposit of iron soap on the fibre which adds to its weight. About eight operations are necessary for a 100 per cent. black. The nitrate of iron as usually sold, is rather acid in its character, and as it works best when in a basic condition, it is advisable to keep the baths, when in work, as free from acid as possible. To render it basic the nitrate of iron is heated and a hot saturated solution of soda crystals is added until a precipitate begins to form, the mixture is then boiled for one hour after which it is ready for use.

3rd. *Blue Bottoming.*—The next operation is to dye the silk blue, which is done by immersing it in a bath of yellow prussiate of potash (*potassium ferrocyanide*). This bath contains about 20 per cent. of the weight of the silk of the salt, to which is added 10 per cent. of hydrochloric acid 30° Tw. The bath is heated to

150° F., the silk entered and worked for half an hour, then 10 per cent. more acid is added, and the operation continued for another half hour. The silk will now have acquired a deep blue colour, due to the formation of Prussian blue from the oxide of iron of the last bath and the yellow prussiate; the acid by partially dissolving the oxide enables the reaction to take place more easily. The silk is then taken out and is, after rinsing, ready for the next bath.

4th. *Weighting bath.*—A catechu bath is now prepared by boiling 100 to 150 per cent. of the weight of the silk of catechu in water, straining off and using the decoction thus made. The bath should stand at 4° to 5° Tw., strong baths are not advantageous. The bath is heated to a temperature of 120° F., the silk entered and worked for an hour; it is advisable, though not absolutely necessary, to allow it to steep over night. The silk absorbs the tannin matter of the catechu from the bath, which increases its weight from 10 to 12 per cent. A heavier weighting can be effected by using the bath at 150° F., when not only does the silk absorb the tannin, but the blue on it is decomposed, and the tannin combines with the oxide of iron on the silk, and the latter increases in weight from 35 to 40 per cent. To attain the heaviest weights it is necessary to work for 2 hours at 150° F., and then leave the silk steeping in the bath all night.

The catechu bath can be freshened up by adding new catechu decoctions or liquors of 18° to 20° Tw. strong, keeping the bath at about 5° Tw. As a rule old catechu baths work better than new ones, the colour becomes deeper and more pleasing, and the

weighting heavier. The pale variety of catechu (gambier), should be used, as the dark variety (cutch) does not yield satisfactory results. The colour imparted to the silk at this stage of the operations by a cutch bath, does not resist the action of the soap baths which are subsequently used, as does the colour obtained from a gambier bath.

This bath is a most important one in the dyeing of weighted black silks, and the dyer, by regulating the conditions of its use, has at his command the means of varying the weighting of the silk to an astonishing degree. For light weights 100 per cent. of catechu only is required, for heavy weights 200 per cent. may be used.

For very heavy blacks it is necessary to use tin crystals with the catechu. This combination is carried out as follows :—A catechu bath is prepared as before and the silk is worked in it from $1\frac{1}{2}$ to 2 hours at 120° to 150° F., it is then lifted out and wrung ; 10 per cent. of tin crystals previously dissolved in water are now added to the bath, in which the silk is then completely immersed, the liquor being kept at 150° to 160° F., for two hours, the silk is then left in the bath, which is allowed to grow cold, for 12 hours ; it is then taken out and rinsed, in readiness for the next bath.

The proportion of tin crystals used is regulated by the number of iron baths that have been previously given to the silk ; if 2 baths of iron have been given, 5 per cent. of tin crystals is used ; if 4 to 5 baths of iron, then 8 to 10 per cent. of tin crystals ; if 8 iron baths have been given then 15 per cent. of tin crystals should be added to the catechu bath. The action of

the tin is somewhat obscure, probably it is complex; a tannate of tin will be deposited on the fibre; part of the oxide of iron already on the fibre which is in the state of ferric oxide will be reduced to ferrous oxide, at the same time tin oxide will be deposited on the fibre; when the silk is exposed to the action of the air, the ferrous oxide will absorb oxygen and be converted into ferric oxide—all these various reactions tending to one end, increasing the weight of the silk.

The catechu-tin bath after being once used cannot be freshened up in the same way as a simple catechu bath, and hence must be thrown away.

After the silk has been worked on the catechu-tin bath, it is a good plan to give it half an hour in a plain catechu bath, the tannin of which combines with the oxides of tin and iron on the fibre, fixes them, and is fixed by them.

All the operations so far have had for their object the weighting of the silk, although the bluing and catechu baths will have some influence on the finished result; after these come the dyeing operations proper. These are at least two in number, 1st, the mordanting, 2nd, the dyeing. The first of these forms the fifth operation in the series.

5th. *Mordanting.* A bath of iron liquor (pyrolignite of iron) at 12° to 14° Tw., and at 112° to 130° F. is provided. The silk is entered, well worked in this for one hour, then wrung out and hung up to age for two hours, after which it is ready for the next operation.

6th. *Dyeing.*—A bath of logwood liquor of 8° Tw. is prepared. This will take from 40 to 50 per cent. of

the weight of the silk or logwood, or an equivalent quantity of extract (from 5 to 10 per cent.); if a jet black is required a little fustic (5 to 10 per cent.) must be added. To this bath, when ready, 25 per cent. of soap is added. It is used at a temperature of 150° F. The silk is entered and worked for one hour, then it is taken out and wrung. Sometimes the black does not come up full enough, in such a case the treatment in the catechu, iron liquor, and logwood baths are repeated.

The next operation in the process has for its object the restoration of the lustre and "feel" to the silk, which has to some extent been deteriorated by the many operations through which it has passed.

7th. *Brightening* is carried out by passing the silk through a bath of Gallipoli oil; 2 to 5 per cent. of the oil is made into an emulsion by shaking it up with a strong saturated solution of soda crystals, or a weak caustic soda solution of 3° Tw. may be used. When the oil is thoroughly emulsionated, it is added to the brightening bath, the silk worked in it until thoroughly impregnated with the oil, then it is taken out, the surplus liquor wrung out, and it is dried. The addition of a small quantity—½ to 1 per cent.—of acid is advisable; organic acids, such as citric, oxalic, tartaric, or acetic acids are the best, though sulphuric acid may be used; I have obtained very good results with oxalic acid. Gallipoli oil is commonly used, but any other oil is equally good. I have used sulphated castor oil with very good results, and it possesses these advantages over Gallipoli oil, that it is soluble in water, hence the silk gets more uniformly impregnated with

it, and that it has no tendency, like Gallipoli oil, to separate out from the bath, which increases the labour of preparing the bath, and prevents a uniform oiling of the silk.

Blacks of different weightings are got by varying the operations, by increasing or decreasing the number of iron and catechu baths, and as hints on this point have been given, it is not necessary to deal further with the subject.

Lead was used at one time as a weighting agent in conjunction with iron, but is now rarely employed. It gave a rather bluer shade of black than that given by the process described above. This method was carried out as follows:—A bath of basic acetate (sugar) of lead is prepared by boiling 13 lbs. white acetate (sugar) of lead with 9 lbs. of litharge in sufficient water for two hours, finally making the bath stand at 52° Tw. Into this the silk is dipped from seven to nine times, it is then wrung out and hung up for six hours, or over night. A bath of sulphuric acid of 8° Tw. is prepared, and into this the silk is entered for a few minutes, taken out, washed well with water, passed through a soap lye, rinsed, and wrung out. It will now be weighted to about 50 per cent.; if a greater weighting is required, the various operations are repeated as often as may be necessary. When the silk has been weighted sufficiently, it is ready for the first dye bath, which is made with logwood liquor of 8° Tw., containing a little soap, in which it is allowed to remain for an hour, being turned at intervals; the temperature of the bath should be about 120° F. It is taken out, washed, and entered into a

bath of iron liquor (pyrolignite of iron) at 40° Tw., in which it may be allowed to steep from twenty-four to forty-eight hours. After wringing it is entered into the second dye-bath, made of logwood liquor, at 8° Tw., 25 per cent. of soap and 5 per cent. of fustic being added. This is used at from 150° to 180° F., and the silk is worked in it from one and a-half to two hours. Then it is wrung out, re-entered into the iron liquor, wrung out, and allowed to steep for twenty-four to thirty-six hours in a bath of gall liquor of 15° Tw., and again dyed in the logwood bath. As a rule it will only require brightening to finish it.

Light Black.—A simple unweighted black on silk is obtained by the following process:—1st, Boil off as usual; 2nd, Mordant in a cold bath made by mixing equal parts of nitrate and pyrolignite of iron together, the strength of the mixed bath being about 35° to 40° Tw.; 3rd, Dye in a decoction of logwood at 8° Tw., adding about 5 per cent. of fustic. Some dyers make this bath of 50 per cent. of the weight of the silk of logwood, 5 per cent. fustic, 5 per cent. copperas, 5 per cent. verdigris. It is used at 140° F.; 4th, Dye in a bath of logwood and soap; 5th, Brighten with oil.

English Black.—This old Black is dyed according to the following scheme:—1st, Mordant with nitrate of iron, preferably made basic; allow the silk to lie in the air for a few hours, then wash and soap at 180° to 190° F.; 2nd, Dye with 50 per cent. logwood, 10 per cent. fustic, 10 per cent. copperas, and 2 per cent. verdigris; 3rd, Dye in a new bath with logwood 35 per cent., and soap 20 per cent.; 4th, Brighten with

oil and acid. This black is not so much used now as it was twenty years ago; methods of dyeing which give more weighting have displaced it, especially the system which was introduced about 1860, and known as Lyons black.

Lyons Black.—This is not a heavy black, the amount of weighting not exceeding 10 per cent. The process in outline is:—1st, Mordant in nitrate of iron, 50° Tw., once, wash; 2nd, Soap; 3rd, Dye blue with yellow prussiate (ferrocyanide) of potash, acidified with hydrochloric acid; 4th, Mordant with nitrate of iron as before; 5th, Catechu bath, 50 per cent.; 6th, Mordant with a cold bath of alum, wash; 7th, Dye with logwood 50 per cent. and soap 20 per cent.; 8th, brighten. All these operations being carried out in the manner already described.

2ND. TANNIN BLACK.

Tannin Blacks are dyed on silk without logwood, and are produced with such tannin substances as sumac, chestnut, galls, valonias, catechu, etc. These tannin blacks can be dyed in shades varying from a blue or purple to jet black; in weight from 0 to 200 per cent. or even higher. They are not difficult to dye, and are very durable in wear; they give soft and full feeling silks and are therefore much used for sewing and embroidery silks, trimmings, plushes, etc. The following descriptions will show how these tannin blacks are dyed, but the processes can be varied to a great extent.

Fine Souple Black.—1st. Mordant in the manner

previously described (p. 36) with a bath of basic sulphate of iron, using it at from 30° to 35° Tw.

2nd. Prepare a bath, of 50 per cent. of the weight of the silk, of soda crystals. Heat from 90° to 100° F.; enter the silk and work for one hour, lift, wring, and wash. These operations are repeated according to the weighting desired. For a light souple, weighted to 50 per cent., one bath is sufficient; for 70 per cent. weighting, two baths are required; for 80 per cent., three baths; for 100 per cent. four or five.

3rd. The silk is now dyed blue with a bath of yellow prussiate and potash acidified with hydrochloric acid in the same manner as logwood blacks (see p. 37).

4th. Soupling bath. The next operation has for its object the soupling or softening of the silk; this is done in a bath containing a decoction of 20 per cent. of galls, and 20 per cent. of divi divi. The bath is heated to 200° F.; the silk well worked in it from two to three hours, or until it has acquired the desired amount of souple; then it is left in the bath until the latter is cold, after which it is taken out, wrung slightly; 10 per cent. of tin crystals are now added to the bath, and after thoroughly stirring, the silk is re-entered, worked for half-an-hour to an hour, taken out, wrung and washed. The bath is useless afterwards, though the tin it contains is worth recovering.

5th. The silk is now soaped in a bath containing about 25 per cent. of soap at a temperature of 50° F. for one hour; it is then wrung out and washed.

As a rule, the black so obtained will be deep enough, but if not, operations 4 and 5, with an immersion in a

weak iron bath, if necessary, will bring it up to the desired shade.

6th. Brightening, which is done with oil (see p. 41).

Another black on silk is obtained by the following series of operations :—

1st. Tannin bath. This is made of chestnut extract and stands at 10° Tw. About 100 per cent. of extract will be required. The silk is entered and worked sufficiently long to give it the necessary amount of souple, which depends on the quality of the silk being dyed. Chinese silk requires a longer time and a hotter bath than Italian silk. Indian silk takes about one hour, and a temperature of 180° F.

2nd. Iron bath. The silk after being taken out of the last bath is entered into a bath of iron liquor (pyrolignite of iron) at a strength of 12° to 14° Tw., the temperature of the bath being about 120° F. ; in this it is kept for half-an-hour, then it is taken out, wrung, and hung in the air to oxidize for five to six hours. It is then re-entered into the chestnut bath at about 100° F., wrung lightly, and again passed into the iron bath. These operations are repeated according to the depth of colour and weighting required. Two repetitions will give a fair black, weighted to about 50 per cent. ; four will give about 100 per cent. ; eight up to 200 per cent. ; fourteen or fifteen up to 400 per cent. The iron bath may be freshened up by additions of new, stronger liquor, keeping it at 12° Tw., which is a good working strength. It gets acid, and consequently useless, by long working, and it can be restored by heating with scrap iron, skimming off any scum that may collect, and bringing it up to 12° Tw

by adding new pyrolignite. When the silk is properly dyed, it can be brightened by methods already given.

Raven Black on Silk.—This is a purplish-black, and is obtained as follows: 1st. Boil off the silk. 2nd. Prepare a bath of a decoction of 20 per cent. of sumac, and 30 per cent. of valonias; heat to 150° F., enter the silk, work well for one hour, then allow it to remain in over-night. 3rd. Prepare a bath with bark extract, 15 per cent.; copperas, 10 per cent.; heat to 120° F., enter the silk, work for one hour, then allow it to cool, the silk remaining in the bath in the meanwhile; lift and wring. 4th. Work again in the original sumac and valonia bath for one hour, wring. 5th. Prepare a weak (5° to 8° Tw.) bath of pyrolignite of iron, run the silk through this for a quarter of an hour, take out, wring lightly, hang in the air for five to six hours, then wash. 6th. Brighten with oil and acid in the usual way. This gives a fine purplish-black on the silk.

Sometimes after dyeing the silk has a rough, harsh feel, which it is necessary to remove; this may be done by oiling it, or by treating the silk to a fuller's earth bath. A quantity of fuller's earth (proportion 1 lb. to the gallon) is well stirred into warm water. The silk is well worked in it for about half-an-hour, taken out, wrung lightly, then hung up to dry, after which it is beaten to get out the surplus fuller's earth.

Tussah and other wild silks can be dyed black by the processes given above; it is, however, essential that they be well "boiled off" and free from grease, otherwise the mordants and dyes do not take well

Moyret gives the following process for dyeing black on Tussah silk: 1st. Boil off with weak caustic soda, wash well. 2nd. Mordant with nitrate of iron (the basic variety gives the best results), fix in weak caustic soda. 3rd. Dye blue with ferrocyanide of potassium (yellow prussiate of potash) in the usual way. 4th. Tan the silk with chestnut extract (see p. 46). 5th. Mordant with iron liquor (pyrolignite of iron). Repeat the 4th and 5th treatments if necessary. 6th. Brighten with oil and acid.

With care very little difficulty should be experienced in dyeing wild silks black.

The shade of black obtained by the processes described above is largely dependent on the kind of iron mordant used. Pyrolignite of iron (iron liquor), and ferrous sulphate (copperas), give blue shades of black. With all varieties of nitrate of iron redder shades of black are obtained; by using a mixture of both mordants, a jet black is obtained. The variety of tannin material used also has some influence.

3RD.—COAL TAR BLACKS.

The blacks obtained from coal tar are but few in number, although there are signs that in the next few years several more will be added to the list. These are not as well known to silk dyers as they might or ought to be, perhaps because they do not lend themselves very readily to weighting processes. The following are the coal tar blacks at present available.

1. Aniline black.
2. Napthol black.

3. Alizarine black.
4. Jet black.
5. Napthylamine black.
6. Acid black.

The best of these are Aniline and Alizarine blacks; they are, however, rather difficult to dye on silk, the result being in most cases somewhat uncertain.

1st. *Aniline Black.*—This is the most permanent of all blacks, but it is also one of the most difficult to dye; the results are always more or less uncertain, on silk more so than on cotton or wool, and hence as a rule silk is very rarely dyed with aniline black. The process of producing an aniline black is by the oxidation of a salt of aniline and toluidine; the best and most commonly used oxidants are the bichromates and the chlorates of potash and soda; occasionally the ferro- and ferri-cyanides of potassium are employed in addition, as well as salts of vanadium, copper and the persalts of iron.

Aniline black must be produced direct on the fibre itself, because, if formed separately, it cannot by any means be dissolved again so that the dyer can use it. In this lies one of the difficulties of getting an invariably good black, especially as everything required in the process must be in good order, and the amount of materials well proportioned. For dyeing silk, two methods can be adopted, both of which in the author's hands have yielded good results.

Direct Aniline Black Process.—A stock solution is prepared as follows:—10 lbs. of aniline oil of good quality are poured into 2 gallons of water, in which $1\frac{1}{2}$ gallons of hydrochloric acid of 30° to 32° Tw., are

thoroughly mixed, afterwards 30 gallons of water are added. One gallon of the aniline mixture, thus prepared, is added to 2 gallons of water to form the dye bath. Into a sufficient quantity of the bath the silk is worked from half to three-quarters of an hour either in a cold or in a warm bath of about 120° F. It is then wrung out lightly and worked in the developing bath made by dissolving 10 lbs. of bichromate of soda in 100 gallons of water; sufficient of this liquor is taken to work the silk in comfortably, adding enough sulphuric acid to make it slightly acid. The silk is worked in this until it acquires a deep black colour, which will take about half an hour. If the silk only becomes brown, it is advisable to wring it out of the bichrome, rinse, and re-enter it in the aniline bath, then enter it into the bichrome bath. On the other hand, if the silk has a tendency to go green, it indicates an insufficiency of bichrome or that the bath is too acid; the remedy is to add fresh unacidified bichrome. When the proper colour has been developed, take the silk out of the bath, wring and rinse well.

It is a good plan, after working in the first bichrome bath for half an hour, to take it out, wring, and enter into a fresh bichrome bath; this latter can afterwards be used as the first bichrome bath for a new batch of silk. The bichrome baths are useless after they have been once used, but the aniline baths may be kept and freshened up from time to time by additions from the stock solution.

After dyeing, the silk can be brightened in the usual way.

Some writers recommend preparing the silk by

working in a bath of bichromate or permanganate of potash, but I have found no advantage in so doing.

Indirect Aniline Black Process.—Another method of working which, in my hands, has given good results, is very economical, but takes a longer time to carry out. A bath is prepared as follows:—(*a*) 3 lbs. of aniline are mixed with 3 lbs. of hydrochloric acid, 30° Tw., diluted with 1 gallon of water; (*b*) 6 lbs of yellow prussiate (ferrocyanide) of potash are dissolved in 4 gallons of water; (*c*) 5 lbs of chlorate of potash are dissolved in 5 gallons of water. The three solutions are mixed together, and the silk is worked in the mixture for about half an hour; it is then taken out, wrung lightly, and placed in an ageing chamber heated to about 150° F., and left for about fifteen to twenty minutes; then it is introduced into a steaming chest at a pressure of 5 to 10 lbs., and steamed for half an hour. It will now have acquired a fairly good black colour, which is more fully developed by passing into a bath of bichromate of potash of a strength of about ½ lb. to the gallon. It is then rinsed in water and brightened in the usual way.

By using the bath warm, the production of the black is hastened, but it is not so firmly attached to the fibre, and hence rubs off more easily than when cold baths are used. Again, by using stronger baths the process may be hastened, but there is a greater waste of material and the black formed is loose on the fibre and rubs off very easily, so that it is advisable to use the weakest baths that will give the desired results.

The receipts given above may be somewhat varied,

and every aniline black dyer ought to make his own baths of the strength that he has found best suited to his own particular method of working.

The great fault of aniline black is a tendency to turn green by wear. This has been found to be more common with blacks produced with chlorate of potash, than with those done with bichromate of potash, which latter are therefore to be preferred. Blacks obtained with pure aniline oil, although the best so far as the blue black shade is concerned, are more liable to turn green than blacks got from toluidine; on the other hand, toluidine blacks have rather a brownish tone, which is objectionable. It may be noted, however, that ortho-toluidine gives a bluer shade than para-toluidine, which gives a very brown shade of black; a mixture of aniline and ortho-toluidine would give better results than either base used separately.

In some receipts for making the aniline baths to be found in works on dyeing, sulphuric acid is recommended in place of hydrochloric acid, which is a mistake, as aniline sulphate, not being so soluble as the hydrochlorate, the aniline is thrown down to the bottom of the bath and is not used. A little sulphuric acid, about $\frac{1}{10}$ to $\frac{1}{12}$ of the aniline used, is a rather useful addition to the bath as it quickens the production of the black. The use of equal proportions of aniline and hydrochloric acid is generally recommended, but I have always obtained better results by using a larger proportion of hydrochloric acid, especially when working according to the first of the two methods given above.

Alizarine Black on Silk.—Alizarine black is a

patented dye-stuff made by the Badische Anilin und Soda Fabrik, and is the bisulphite compound of Napthazarine. For wool-dyeing its application is easy, and it has been successfully used ; in silk-dyeing it has not been so successful, the mordanting of the silk not being easily accomplished. I have been most successful in dyeing with Alizarine black by the following process. Boil off the silk as usual, then prepare a bath with 60 to 70 per cent. of acetate of chrome 12° Tw. ; enter the silk, and boil well for one and a half to two hours, turning over the silk from time to time ; finally the silk will have acquired a faint greenish tint. The silk must be so well boiled that the acetate of chrome is effectually decomposed, the acetic acid being driven off and the oxide of chrome deposited on the silk. Rinse, but do not dry the silk. Then prepare a cold dye-bath with 20 to 25 per cent. of Alizarine black S.W., and about $\frac{1}{10}$ per cent. of acetic acid. Enter the silk in this, and turn for half-an-hour ; then gradually raise to the boil, and boil well from about one to one-and-a-half hours until the black is fully developed. Then rinse well and dry. The secret in dyeing Alizarine black on silk seems to lie in thoroughly boiling the silk in both the mordanting and dyeing bath. It is not a cheap process, but the advantage of obtaining a black that is proof against acids, light, and washing, will perhaps counterbalance this.

Another method of dyeing Alizarine black on silk is to mordant the silk in a bath containing 4 per cent. of bichromate of potash and $1\frac{1}{2}$ per cent. of tartar, entering the silk cold, and then raising to the boil and

working until the silk has become of a pale green colour. Rinse the silk out and dye as in the last process. This method has not yielded as good results as the acetate of chrome process in my hands, the shade obtained being rather redder. In both processes the small loss of lustre can be restored by any of the usual brightening processes. The silk is left perfectly soft and supple, free from any harsh and disagreeable feel, which is a great desideratum. The chrome acetate process yields the best results, the silk dyed with bichromate being slightly harsher to the touch. The boiling of the mordanting and dyeing baths should be done with a closed steam coil (dry steam), or by fire, so that as the operation proceeds the baths get stronger from evaporation; open steam should be avoided. The quantity of water used in the first instance should not be more than enough to enable the silk to be worked comfortably in the bath.

Napthol Black on Silk.—Napthol black is a patent colouring matter made by Messrs. L. Cassella and Co., in various brands, of which the mark P. is special for silk, to which it gives a deep blue black shade by the following process: Prepare a dye bath with 10 per cent. of the weight of the silk of Glauber's salts, 3 per cent. soap, 2 per cent. sulphuric acid, 8 per cent. Napthol black P. Enter the silk at about 130° Fahr., work for fifteen minutes, then raise to the boil and work to shade. The silk loses but little of its lustre, which can be restored by any of the usual brightening processes. The shade obtained is a blue black. A jet black is obtained by adding 1 per cent. of Indian

yellow to the above dye-bath. The black then obtained is a good, full, jet black, very solid and lustrous.

Silk dyed with Napthol black is very resistant to the action of acids, alkalies, and light, and it stands washing very well, Napthol black being one of the fastest colouring matters known. It is not so cheap as logwood, although the price has been lately materially reduced by the makers to enable it the better to compete with that dye-wood; on the other hand, it has the very decided advantage of being permanent, a fact which in many cases will more than counterbalance its slightly increased cost. It does not admit of weighting so readily as logwood, but when it is desired to weight the silk and use Napthol black to obtain a fast acid-resisting dye, the following process may be adopted. Weight the silk with catechu and nitrate of iron, as previously described, p. 36, second and fourth operations; then dye as above with 4 to 5 per cent. of Napthol black P., and ½ per cent. Indian yellow. The number of treatments with catechu and nitrate of iron determine the weight given. The process gives a full, solid, heavy black, which resists acids and light, and is scarcely affected by soaping.

Napthol black P, and the newer brand, 3 G, are very useful to the silk-dyer, giving a great variety of useful shades from slates to navy blues and blacks; these will be described in fuller detail further on.

Jet Black on Silk.—Jet black is a product recently (1889) sent out by the Farbenfabriken vorm. F. Bayer and Co. It is sent out in two shades, R and G, the R giving a blue, and the G a greenish

shade of black; mixed together they give a jet black. They are easily applied; a dye-bath is prepared with 5 per cent. of colouring matter, 10 per cent. of salt, and from 1 to 2 per cent. of soap; this latter is not absolutely necessary. The bath is heated to about 130° F.; the silk is entered and worked for a few minutes, then the temperature is raised to the boil, and kept at that heat until the colour is properly developed on the silk, which is then lifted out, washed, and dried. The black thus obtained is thoroughly fast; it resists washing, alkalies, dilute acids, and strong hydrochloric acid, and is untouched by light and air.

Napthylamine Black.—This black has been lately offered to dyers by Messrs. L. Casella and Co., and from some experience of it the author is of opinion that it will be found very useful in silk-dyeing. Like Napthol black it does not of itself produce a full black, but gives with 4 to 5 per cent. of the dye, purplish shades of black, and in smaller quantities useful shades of slate lilac. To get a full black requires 4 per cent. of Napthylamine black and $\frac{1}{4}$ per cent. of Indian yellow. The dyeings are done in a bath containing Glauber's salts (10 per cent.), and acetic acid (5 per cent.), at the boil for one hour, then lifted, washed, and dried. The black resists washing, soaping, and is fairly fast to acids and light. It will be found very useful as a combination colour in drabs, greys, slates, etc.

Acid Black.—This is a new black colouring matter sent out by Messrs. Read Holliday and Sons, in two shades, B and BB; it dyes silk in an acid bath in the

same way as Napthol black. With 4 to 5 per cent. of dye-stuff, it gives deep shades of a reddish tone of black; to obtain a jet black it is advisable to add a little Acid blue to the dye-bath. It is a good colour, and will be found very useful, being fast to acids, although it is only moderately fast to soaping. For pale shades it is not very suitable.

Napthol Black is the best black to use for dyeing mixed silk and wool fabrics, as it dyes both fibres very evenly.

Wild silks may be dyed with any of these blacks without much difficulty, care being taken that they are free from grease before entering into the dye-bath.

CHAPTER IV.

DYEING OF FANCY COLOURS ON SILK.

HAVING dealt with the dyeing of black on silk, we will now proceed to the dyeing of fancy colours, reds, blues, greens, violets, etc., on silk. This is rather a difficult subject to compress into a small space, the number of dyes is so great, the variety of shades so infinite, and the number of combinations of dyes to produce these shades so numerous, that it would take a book as big as a volume of the "Encyclopædia Britannica" to give them all, and even then it would be a mere collection of recipes of little use to the dyer. I propose to deal with the subject in a manner which I hope will give a clear idea of the materials and methods in use for dyeing fancy colours on silk, pointing out at the same time the principles underlying these methods, so that the silk-dyer will not be at a loss to apply these principles to any particular case. In the appendix will be found numerous recipes with patterns showing more in detail how particular tints and shades can be obtained.

WEIGHTING OF SILK FOR FANCY COLOURS.

Fancy coloured silk goods are generally purer than black and sad coloured silks. It is not so easy to

weight the former as the latter, because there are few substances which while being capable of giving weight, yet possess those other qualities desirable for the purpose, such as freedom from colour, affinity for the silk fibre, and neutrality in their effect on dyes. The weighting agents most generally used are sugar, acetate of lead, perchloride of tin and tannin.

Weighting Silk with Sugar.—The weighting with sugar is done after the silk is dyed. A solution of sugar is made from pure crystal, or lump sugar, by placing it in a copper or enamelled iron pan, with just sufficient water to cover it. This pan is placed inside another pan containing water, thus forming a kind of "bain-marie" or glue-pot arrangement. The whole is heated by gas or fire until the sugar is dissolved. Any other means of dissolving the sugar may be employed, but direct heating should be avoided because of the risk of charring. When completely dissolved, add water, so that the solution shall contain about 3 ozs. sugar to one pint of water and stand at about 12° Tw. Old sugar baths can be used for diluting, care being taken that the new baths are only used for the same colours as the old, the degree Twaddle will indicate the right strength (12°) of the dilution. A head of silk (8 ozs.) is taken and shaken in the bath till it is saturated, it is then wrung out gently and levelled in by pinching it tightly in its whole length, so as to get the silk evenly saturated, but not so much as to press out all the sugar it has absorbed. It is then dried and finished as usual, or the dipping process may be repeated if necessary. One steeping will weight the silk to the extent of

about 12 per cent., two to about 20 per cent. The old baths can be kept up to the working strength (12°) by the addition of new solution of sugar of about 25° Tw. strength.

Weighting Silk with Acetate of Lead.—Silk is weighted with acetate (sugar) of lead by making a solution of the basic acetate of lead by boiling litharge with a solution of acetate of lead. This weighting solution is used at a strength of 50° Tw. Dip the silk in this liquor, take it out, wring, expose it to the air for five to six hours, then run through cold sulphuric acid sours at 8° Tw., wash. One dip will weight to about 8 per cent., if more weighting is required the operations are repeated. In this case the weighting is generally done on the undyed boiled-off silk, although it may be done on the dyed silk if the colour is such as will stand acid.

Weighting with Perchloride of Tin.—This process is of recent introduction and is largely practised on the Continent, whence it has come into this country. Stannic chloride or perchloride of tin, $Sn\ Cl_4$, is a strongly acid liquor usually sold at a gravity of 110° to 112° Tw. In buying, care should be taken to ascertain that the sample is free from the muriate of tin (stannous chloride). For this purpose dilute it with about ten times its volume of water, prepare a starch solution, add a few drops of iodine solution—just enough to give a pale blue colour—then add some of the diluted tin solution; if the blue colour be discharged, the sample of perchloride should be rejected. Muriate of tin has a decolourizing action on some coal tar colours and therefore the use of the

sample might lead to undesirable results. Perchloride of tin can be made by taking $4\frac{1}{2}$ lbs. of tin crystals, dissolving them with a gentle heat in $4\frac{1}{2}$ lbs. of hydrochloric acid of 30° Tw.; $14\frac{1}{2}$ ozs. of chlorate of potash are added in small quantities until the solution has acquired a deep yellow colour, or until all the protochloride (stannous) has been converted into perchloride (stannic). For weighting purposes a liquor is made by diluting with water to 50° Tw. Stannic chloride has a strong solvent action on silk; at 60° Tw. the silk is tendered considerably, while a solution of 70° to 75° Tw. dissolves the silk completely. It is well therefore to use nothing stronger than 50° Tw., and weaker liquors may be used with advantage. The silk is first wetted out with water, wrung and laid in the weighting bath for two hours, then wrung out, washed in water, or run through a bath of soda crystals. One dip will weight about 8 per cent., if this is not enough the process can be repeated, two dips will weight about 15 to 16 per cent., three dips to about 25 per cent. It is necessary to wring the surplus liquor out of the silk by means of a wringer, as the hands would be injured by contact with the strong acid liquor. It should be well washed, as any tin liquor left in it is liable to lead to tendering of the silk fibre. Usually the weighting is done on the raw silk, but it can be done on the boiled off silk equally well and always before dyeing.

The baths after being used should not be thrown away, as they contain large quantities of tin, which can be recovered from them. The exhausted baths should be collected in a tank; when sufficient has thus been

stored the tin is recovered by adding milk of lime, which precipitates the tin as oxide. This can then be collected by allowing the precipitate to settle, the clear top liquor is run off, the residue washed by pouring water on and stirring well; it is now filtered and dissolved in hydrochloric acid to form fresh perchloride for use again as a weighting agent.

Silk can also be weighted by means of stannate of soda, by immersing it in a bath of 15° Tw. strong, and leaving it from one and a half to two hours, taking out, wringing, and running through a dilute 5° Tw. sulphuric acid bath. Care must be taken that the stannate of soda is not too alkaline, but as neutral as possible; if too alkaline there is a risk of damaging the silk. One dip will weight the silk about 5 per cent.; by repeating the operations about eight times the silk can be weighted to 25 per cent.

Silk can also be weighted with pink salt (ammonia stannic chloride). The raw, or boiled-off silk, is entered from 2 to $2\frac{1}{2}$ hours in a cold bath at 47° to 51° Tw. of the salt; it is then wrung out, and passed into a fixing bath of soda crystals 30 per cent., and soap 3 per cent. of the weight of the silk for one hour at about 90° F., after which it is wrung out, rinsed and dried. One complete operation will weight the silk from 40 to 60 per cent., twice from 60 to 90 per cent.; three times from 90 to 110 per cent., and four times from 110 to 130 per cent. There is considerable loss of elasticity and strength by this process. The loss of elasticity averages about 29 per cent., the loss of strength about 10 per cent.

Weighting silk with tannin.—Silk has the property

of absorbing tannin from its solutions, which property is useful in the dyeing and weighting of black silks, but until recently could not be used for fancy colours, as most commercial tannins impart a pale brownish colour to the silk. In 1890, several processes were adopted for de-colourizing tannin products, and clear colourless tannin can now be obtained which can be used for weighting silks for fancy colours. The process is comparatively simple: a bath of tannin containing 1 lb. of tannin in the gallon of water is made, and the silk is immersed in it for one hour, and turned over frequently during that time; the silk is then taken out, wrung and dried. Steeping for one hour in a solution of tannin of the strength given will weight the silk about 26 per cent., a two hours' steep to about 29 per cent., and a three hours' steep to 32 per cent. By using weaker solutions the amount of weighting is deceased, thus a solution of half the strength for one hour will weight to about 16 per cent. By passing through a fixing-bath made by dissolving half a pound tartar emetic in one gallon of water, the tannin is fixed on the fibre, and the weighting is increased from 4 to 5 per cent. The baths should be used at from 100° Fahr. for light to 160° Fahr. for heavy weighting. They can be kept for future use by being replenished with fresh material from time to time, fermentation being prevented by the addition of a small quantity of carbolic acid.

By this process the strength and elasticity of the fibre is very little impaired, but it is swollen somewhat, and there is a loss of lustre, which can be partially restored by a weak acid bath.

Dyeing Reds on Silk.

The number of red tints is very great, ranging from the palest and most delicate pinks, through the various shades of scarlet, to the deepest crimson. The colouring matters which are used to dye these tints on silk are derived from,

1st, Natural Colouring Matters, such as cochineal barwood, etc.;

2nd, The Coal Tar Colours.

For details of the origin, chemical composition and methods of preparation, reference must be made to such books as Benedict and Knecht's "Chemistry of Coal Tar Colours," and Grace Calvert's Cantor Lectures on "Colouring Matters other than those derived from Aniline."

Dyeing Silk Red with Natural Colouring Matters.

There are not many natural reds used in dyeing silk: cochineal, peachwood, Brazil wood, cudbear and safflower being those most frequently employed. Cochineal is (or rather was, for its place is now taken by many of the azo reds derived from coal tar) used for producing a great variety of tints from a pale pink to a deep crimson; in conjunction with annotto and Persian Berries it is used to dye scarlets. It requires the silk to be mordanted with tin or alumina to produce permanent shades of brilliant hues. The methods of dyeing silk with cochineal vary according to the shades required. The following recipes will serve to show what these methods are:—

Crimson on Silk with Cochineal.—For 10 lbs. of silk :—

1. Make a saturated solution of alum, and use enough to cover the silk. Enter the silk, work well for half-an-hour, then allow it to steep all night. Take out and wash well. Dye in a decoction of 4 lbs. cochineal. Enter the silk at 120° F., work for a short time, then slowly heat to the boiling point, dye to shade, lift, rinse well and dry.

Cochineal decoctions are generally made by taking the quantity of cochineal, pouring on to it about one gallon of boiling water for each pound of cochineal, then boiling for about a quarter of an hour ; straining through a cloth filter, and using the clear liquor thus obtained. To extract the whole of the colouring matter from the cochineal, a quantity of boiling water may be poured over the residue on the filter, and the liquor may be added either to the first obtained, or used in the preparation of a new decoction.

2. Another method is (for 10 lbs. silk) to take 3 pints of oxymuriate (perchloride) of tin, dilute with hot water to a convenient quantity and immerse the silk in this bath, work the silk well for two to three hours, take out, lift and wash. Prepare a decoction of $3\frac{1}{2}$ lbs. cochineal, enter the silk and dye as above. Take out, rinse and dry.

This colour is sometimes called "grain" crimson. (Cochineal colours on silk are generally called "grain" colours). By varying the quantity of cochineal a great variety of shades, from a pale rose to a deep crimson, can be obtained ; 1 oz. of cochineal to 1 lb.

of silk gives a pale rose, $2\frac{1}{2}$ ozs. a medium shade of crimson, $3\frac{1}{2}$ to 6 ozs. a dark crimson.

Grain, or cochineal scarlet. – For 10 lbs. silk. First dye an annotto orange in a soap bath, wash well, then mordant the silk in a bath of 4 lbs. perchloride of tin at about 150° F. in the manner described above; then dye in the cochineal bath, using $1\frac{3}{4}$ lb. cochineal for a medium shade, or $2\frac{1}{2}$ lbs. for a full shade of scarlet. It is rare to find a true cochineal scarlet on silk at the present time; similar shades are more easily got with the azo-scarlets which have a greater affinity for the silk fibre than cochineal has.

The tin mordanting baths may be freshened up once or twice by adding fresh tin solution, but they get too acid to be used often. When done with for dyeing the tin can be recovered by the method already described (page 61).

Cochineal colours are very bright, fairly resistant to acids and washing, but are not fast to light.

Crimson can be dyed with peachwood or Brazil wood, the results are not so brilliant as with cochineal and are not so fast. The methods are as follows :—

1. The silk is boiled for half-an-hour in a saturated solution of alum, and dyed in a decoction of peachwood, to which has been added a little muriate of tin.

2. Without any previous mordanting the silk is dyed direct in a warm decoction of peachwood containing a little muriate of tin. The temperature of the dye-bath should not be higher than from 150° to 170° F. About 5 lbs. of peachwood are required to dye 10 lbs. of silk a crimson and $\frac{1}{2}$ lb. muriate of tin will, as a rule, be sufficient.

Claret. The silk is steeped from one to two hours in alum liquor 10° Tw., then washed. The dye-bath is made with 5 lbs. peachwood and ½ lb. logwood, and is used at 160°-170° F., working the silk until the shade is fully developed. Very little logwood is required, if the quantity is increased the colour becomes more chocolate.

Ruby.—This colour is dyed with cudbear, using from 2½ to 4 lbs. for 10 lbs. of silk. If scarlet shades are wanted about ½ lb. muriate of tin is added to the dye-bath; if crimson shades a little ammonia. The dyeing is done at 160° to 170° F., and the silk is worked till the desired shade is developed. The dye-baths need not be thrown away, but can be freshened up by adding new material.

Pink.—1. Pass through red liquor at about 12° Tw., leaving the silk in it about half-an-hour; dye in a warm cochineal bath at 150° to 170° F., use ½ oz. for pale, ¾ oz. for medium, and 1 oz. for dark shades of pink to each lb. of silk. 2. Treat with red liquor as before, and dye in a decoction of peachwood, using 1 oz. for pale, 1½ oz. for medium, and 2 ozs. for dark shades per lb. of silk. Cochineal gives the brightest shades; peachwood is slightly yellow, and not so bright in tone.

Poppy red.—What is called a poppy red is obtained from cochineal as follows: Prepare the silk in stannate of soda at 4° Tw., by soaking for fifteen minutes; then pass through sulphuric acid sours at 2° to 3° Tw., wash well; steep in red liquor at 8° Tw.; expose to the air for twenty-four hours; wash well. Dye in a cochineal liquor of 6° Tw. at 150° to 170° Tw.; if necessary to

bring up the tone, add a little muriate of tin to the dye-bath. This gives a very fiery shade of red.

Flesh.—For 10 lbs. silk, prepare a bath with 1 lb. white soap, 4 ozs. pearl ash, 2 qts. annotto liquor, 1 in 10. Dye at the boil, working to shade; lift, wash, and dry.

Salmon.—Dyed same as flesh, the colour is raised by passing the dyed silk into a weak bath of muriate of tin.

Safflower Pink.—For 10 lbs. of silk. Prior to the actual dyeing operation, the safflower undergoes a preliminary operation. 2 lbs. of safflower are placed in 2 gallons of water, in which has been dissolved 2 ozs. pearlash, and allowed to steep five to six hours, when the colouring matter of the dye-stuff is dissolved, the residual fibrous matter is strained off, and citric acid or lemon juice added to the clear liquor; this precipitates the colouring matter, and such precipitate is sold as extract of safflower. In the extract cotton is immersed for a few hours, when it absorbs the whole of the colouring matter; then the dyed cotton is well washed in water, which extracts a small quantity of yellow colouring matter which always accompanies the pink; afterwards the dyed cotton is placed in a vessel of water containing 2 ozs. of pearlash in solution. This dissolves out the colouring matter from the cotton, which when completely decolourized is withdrawn from the liquor. The liquor which has thus been prepared forms the dye-bath for the silk; to it is added 2 ozs. sulphuric acid, the silk entered, and worked for about half-an-hour; the best temperature to work at is about 100° F. After being dyed, the silk is taken out, washed,

and dried. Safflower pink is by no means a durable colour, as it fades rapidly on exposure to light, and is easily discharged from the fibre by weak alkaline baths. It is now almost entirely replaced by safranine.

2. Dyeing Silk Red with Coal Tar Colouring Matters.

The red artificial colouring matters made from coal tar may be divided into four groups, this classification being based partly on the character of the dyes themselves, partly on the methods of dyeing them on silk. These groups are:

1. *Neutral Reds*, including such colours as Congo red, Benzopurpurine, Erika, Brilliant Congo, Hessian purple, Diamine scarlet B, Titan pink, Titan red; which require a strictly neutral or slightly alkaline bath. These dyestuffs may be mixed together in any way for the production of compound shades.

2. *Basic Reds*, including such colours as Magenta, Safranine, Rhodamine, Pyronine G, Cerise, and the reds obtained from crude magenta, which are sold under a variety of names. They may be mixed in any way for the production of shades.

3. *Acid Reds*, including such colours as Biebrich scarlet, the Ponceaus, Oranges, Azocarmine, etc., which require a more or less acid bath.

4. *Adjective Reds*, like Alizarine, which require a mordant, and whose tint or shade varies with the mordant.

This grouping is also applicable to other classes of

coal tar colours, such as greens, blues, yellows; and any general remarks about them are as applicable to these colours as to the reds.

1. *The Neutral Reds.*—These are dyed at the boil in a bath of old boiled-off liquor, or in a bath containing 5 to 10 per cent. of phosphate of soda, or in a bath containing 10 per cent. of salt. It is only necessary to use soap in the case of Congo red and Hessian purple, which dye best in a weak alkaline bath. Erika, Titan red and scarlet dye best in a salt bath containing a little acetic acid. Boiled-off liquor is only required in the case of half-boiled silks.

Brilliant Congo gives scarlet; Hessian purple, bluish-red; Roseazurine, bluish-pink; Erika, fine bright pinks; Titan pink, pinks; Titan scarlet, scarlet; Deltapurpurine, scarlet; Diamine scarlet B, a fiery scarlet. The proportion required varies according to the shade wanted—pinks can be got with ½ to ¾ per cent., medium shades with 1 to 1½ per cent., and full shades with 2 to 3 per cent. Unfortunately, with the exception of Erika and the Titan colours, none of these are fast to acids or light, though they are fast to soap.

A fairly bright red on silk can be got from Primuline (a yellow colouring matter of this group) by first dyeing the silk in a boiling bath of 8 per cent. Primuline, 20 per cent. salt, 2 per cent. acetic acid. Then, after washing, treating the silk in a cold bath of 1 lb. of nitrite of soda, and 2 lbs. sulphuric acid dissolved in 10 gallons of water. After about ten to fifteen minutes' steeping, it is taken out, washed, and immediately entered into a bath of 5 per cent. of betanapthol dissolved

in $7\frac{1}{2}$ per cent. of caustic soda, 60° Tw. After half-an-hour's working it is taken out, soaped hot, and brightened with acetic acid. The red thus got is bright, and fast to acids, soaping, and alkalies.

One advantage of this class of colouring matters is that they will dye silk, cotton, and wool of nearly the same shade in one bath; it is, therefore, very useful in dyeing mixed fabrics. (See Chapter V.)

2. *Basic Reds.*—These are dyed on silk in hot baths, at 170° to 180° F., containing Glauber's salt, soap, or boiled-off liquor. The reason for using such a bath arises from the great affinity of these colouring matters for the silk fibre; they would dye in a plain bath, only that they strike on the fibre so readily that the portions of the silk first entered are apt to take up more of the colour than the other portions of the silk, so that uneven dyeing is the result. This is experienced most strongly when pale shades are being dyed; in such cases it is better to use larger proportions of the retarding agent, and add the dyestuffs in two or three quantities during the dyeing operation. The substances named have a retarding action, and they, therefore, facilitate even dyeing. Soap is the substance which has been found to give the best results. For thoroughly well boiled-off silk a soap bath can be used; the soap should be pure, free from any objectionable odour or colour. Olive oil soap is a good material to use, or a white soft soap made from cocoanut oil and potash would give good results, from its greater solubility in water. Sulphated castor oil, being freely soluble in water, gives a cleaner dye-bath; care must be taken that the sample used be neutral, free from

excess either of acid or alkali. The only objection is that, unless it is all washed out, it imparts an unpleasant odour to the fabric. The baths may be used until they get too dirty; they should then be collected, heated, and enough sulphuric acid added to neutralize all the alkali present; the mass should be heated until the layer of fat acid which rises to the top becomes clear, it should then be allowed to cool down, and the fat acid separated. If fairly free from colour, it may be converted into soap by adding the requisite quantity of caustic soda or caustic potash. If rather discoloured, it can be bleached by using the spent peroxide of hydrogen baths that have been used in bleaching silk; or, if this is not available, by heating the fatty acid with sulphuric or hydrochloric acid and oxide of manganese. After bleaching it can be converted into soap by treatment with alkali; 1 cwt. of the fat will take about 19 lbs. of caustic soda, 70 per cent., to convert it into soap, which can be used again for making new dye-baths.

For half-boiled off silks, such as schappe, souple, etc., silks, it is almost necessary to use a bath of old boiled-off liquor, as they still contain some silk glue, and if a plain bath were used in dyeing them some of this glue would be dissolved off, thus reducing them in weight, which the silk dyer generally desires to avoid. When old "boiled-off" is used, being saturated with silk glue, it cannot take up any more from the silks dyed in it, so there is no reduction in weight of the silk.

Substitutes for old boiled-off have been made, these are commonly preparations of soap, glue, and oil.

One such preparation is made as follows :—Take $6\frac{1}{2}$ gallons of water, in a portion of this dissolve $1\frac{3}{4}$ lb. of good soap, in the other dissolve 7 ozs. of the best and palest glue ; when both solutions have been made, mix together and stir in 8 ozs. of olive oil and 1 oz. caustic soda, 70° Tw. ; when cold it is ready for use. For deep shades one gallon of this added to four gallons of water forms the dye-bath ; for pale shades one gallon to five gallons of water may be used. It gives fairly satisfactory results, and can always be used in the place of "boiled-off."

The reds belonging to this group are Magenta, Crimson, Safranine, Rhodamine, Pyronine G, and the reds obtained as bye-products in magenta making. They are therefore not very numerous, but they are very useful. They are easily and completely taken up by the silk fibre. In working, pale tints especially, it will be found best to add the colouring matter to the dye-bath in two or three separate portions during the progress of the dyeing operation, to insure the even dyeing of the silk. After dyeing, if necessary, the silk can be brightened by passing through a weak bath of acetic acid.

One per cent. of Magenta crystals gives a fine deep shade ; pale shades of brilliant tints can be got by using from $\frac{1}{8}$ to $\frac{1}{2}$ per cent. of dye. Cerise, Cardinal, Crimson, which are generally impure forms of magenta, have not the same colouring power, $2\frac{1}{2}$ to 3 per cent. being required to give deep shades ; unfortunately Magenta shades, while very brilliant, are not fast to light. There is a great difference in the dyeing power of these dyes made by different makers, much depend-

ing on the price charged. The best are really the cheapest, giving the most satisfactory results, and producing tones which are often more brilliant and better in every way. Then, again, the colouring power is often greater, so that the dyestuff will colour more material for the same cost.

Safranine dyes from pale rose to crimson, 5 per cent. giving the latter, and $\frac{1}{4}$ to $1\frac{1}{2}$ per cent. the former; by combining it with Auramine, Benzoflavine, Thioflavine, fine shades of scarlet are obtained. Safranine shades are faster to light than Magenta shades, though they are not permanent.

Rhodamine gives very fine shades of pink, much resembling those produced by the blue shade Eosins, with the decided advantage that they are faster to light and air, ranking in this respect among the best and fastest of the coal-tar dyes. It dyes easily and well, 2 to 3 per cent. gives full shades.

Pyronine G. dyes bright shades of crimson, moderately fast to light.

3rd. *Acid Reds.*—These reds are very numerous, they are dyed in an acidulated bath ; sulphuric acid is usually applied, but sometimes acetic acid is used. As this group of colours are mostly potassium or sodium salts of what may be called "colour acids," they will not dye silk or wool fibres, and it is necessary that the colour acid should be liberated so that it can combine with the fibre ; for this purpose about 2 per cent. of the weight of the silk of acid is usually added. As the "colour acids" have a strong affinity for the silk fibre, other substances—soap, old boiled-off liquor, or Glauber's salt—are added ; these act by

retarding the absorption of the colour by the fibre, more even dyeing being the result.

For boiled-off silk, Glauber's salt forms the best addition, and the dyer is not troubled with the sticky fatty acid which results from acidifying a soap bath, or a bath of boiled-off liquor.

For half-boiled silks, for reasons stated above, a bath of old boiled-off is desirable, or the substitute given above may be used.

As a rule, the temperature of the dye-bath should not exceed 180° F., it may even in some cases be as low as 150° F. Very few of these acid dyes require the bath to boil.

The red colouring matters of the third group are very numerous, and comprise two or three distinct classes of dye-stuffs, differing in their chemical composition and properties, although there is not much difference in their method of application to the fibre.

The *Eosins* comprise Eosin J., Eosin B., Eosin BN., Rose bengale, Phloxin, Safrosin, and Erythrosin. They are derivatives of fluorescein, prepared by nitrating or iodising or bromising it. They dye very fine shades of pink, the first two named yellowish shades, the others bluish shades; unfortunately these, although very brilliant, and giving shades of rose not obtainable with other dyes, are very fugitive; in this respect the yellow Eosins are faster than the blue shade Eosins. They are usually dyed in a soap bath faintly acidulated with acetic acid. They vary in strength somewhat, but, as a rule, 3 to 4 per cent. gives very full shades, with $\frac{1}{8}$ per cent. blush shades, and with 1 per cent. rose shades are obtainable; they do not readily

combine with other colouring matters, being very distinct in their chemical composition and properties.

The Azo-dyes rank amongst the most important colouring matters at the service of the dyer; the reds of this group comprise the Scarlets, which dye true scarlets of various shades; the Croceine scarlets, which give bluish tones of scarlets; the Ponceaus, which dye crimson shades; the Bordeaux reds, which dye full dark reds. They dye easily and well, and usually have great colouring power. Different makes of professedly the same dye vary very much in brilliance of tone, etc., and dyers should be careful to compare different makers' products, and buy those which give the purest shades and are strongest in colouring power. Often the highest priced dye is the cheapest in the long run. The red azo-dyes are capable of being mixed with other azo-dyes, giving a great variety of useful shades; the number of combinations is so great, that it becomes a practical impossibility in a work such as this to give them in detail. A few recipes will be found in the Appendix.

The resistance of the azo-reds to light, air, washing, and acids is very variable; some of the reds, Bordeaux S, Atlas Acid Scarlet, for instance, are very fast to all these influences; others are fugitive to light, but resist washing; others again are fast to washing, but not to light.

Their application to silk is easy; they may be dyed in a bath of 5 to 10 per cent. of soap broken with 1 to 2 per cent. of acetic or sulphuric acid, or an acidulated bath of old boiled-off may be used; or wherever possible a bath of 10 per cent. Glauber's salt, and

2 per cent. of acetic or sulphuric acid is preferable. Generally speaking they are strong colouring matters, 2 per cent. being sufficient to give full shades; they can be used for pale tints with $\frac{1}{8}$ to $\frac{1}{4}$ per cent. of colouring matter with advantage.

Acid red colours are few in number, comprising such as Acid magenta; these are generally made by sulphonating the basic colours with sulphuric acid. They are dyed in the same way as the azo-reds, which need not be further described.

4th. *Adjective Reds.*—Of this group there is only one representative—Alizarine—which has been known since 1868, and for many years was used only for cotton dyeing; then it came into use for wool, and more recently for silk dyeing. Adjective colours are not entirely successful in silk dyeing, as the fibre has hardly sufficient affinity for some of the best mordants; but with careful attention very good results can be got with Alizarine.

Silk may be dyed with Alizarine in various ways. The following is a very good method, and excellent results can be got from it. After scouring the silk in the usual way, prepare a mordanting bath with—

$4\frac{1}{2}$ lbs. alum,
$7\frac{1}{2}$ ozs. soda crystals,
$7\frac{1}{2}$ gallons of water.

Boil the bath until the precipitate which is formed on first mixing the materials has been re-dissolved. Enter the silk in this bath, work well for fifteen to twenty minutes, then allow to steep over night, or for twelve hours, wring the silk out well, and, as perfect dryness

is not essential, whizzing the silk in the hydro-extractor will dry it sufficiently. The mordanting bath only requires fresh material to be added to be used over again for another lot of silk. Prepare a bath of silicate of soda at not more than 1° Tw., enter the silk in this, work for twenty to twenty-five minutes, lift, wring, and wash well, wring, and the silk will be ready for the dye-bath. The dye-bath is made with—

100 gallons of water,
20 gallons of boiled off liquor.

The latter ingredient must be quite free from soda, which would tend to prevent the Alizarine from going on to the silk. On the other hand it must not contain too much silk glue, as this would cause stains and other defects. It will be found best, therefore, to use the liquor from a second boiling off bath, or even fresh neutral soap liquor. Weak acetic acid is gradually added until the bath is quite neutral. Then the dye-stuff is added: for a medium shade of red 1 to 2 lbs. of Alizarine 20 per cent., per 10 lbs. of silk; for deep shades 2 to 5 lbs.; for pale shades Alizarine pinks ½ to 1 lb. Enter the silk into the bath, work for fifteen to twenty minutes in the cold, then heat gradually during at least three-quarters of an hour to the boil, as the Alizarine fixes itself but slowly on the silk, and rapid heating has been found to cause the colour to be loose. The dyeing is continued at the boil for one hour; the silk is then washed. To brighten the colour it is soaped in a weak soap bath —2 ozs. soap in 6 gallons of water—and boiled for

twenty minutes; take out the silk, wash well, and brighten the silk by passing into water containing $2\frac{1}{2}$ to 3 lbs. acetic acid, 10° Tw. in every 10 gallons; use this at 100 to 120° F., work the silk for ten to fifteen minutes, wring and dry.

The soap in the dye-bath in the present case plays an important part, as there is scarcely any doubt that the fatty acid it contains enters into the composition of the Alizarine-colour lake that is formed on the fibre. It has been found in the case of Alizarine dyeing on cotton that the use of oil in the process causes the colour to be brighter, and analysis of the colour lake produced on the fibre shows that it contains a small proportion of fatty matter; and by analogy the same thing will take place in silk dyeing.

Instead of this process a shorter method can be adopted, but the results are not so good. Steep the silk in alum liquor at 8° Tw., work well for half-an-hour so as to get every part of the silk well saturated with the mordant, then allow to soak for fifteen to twenty hours, wring out, and dye with Alizarine as described above.

Another method is to use acetate of alumina at 7° Tw. instead of the alum. In this case after steeping the silk is wrung out and dried thoroughly, which is best done in a steaming-chest, to decompose the mordant and cause the deposition of the alumina on to the silk. After drying the silk is ready for the dye-bath, which is made and used as above described.

A very good method of mordanting silk for the

Alizarine colours is to prepare a solution of 8 lbs. alum in 4 gallons of boiling water and 4 lbs. hyposulphite of soda (thiosulphate of soda) in 5 gallons of boiling water; when both the solutions are cold mix together, when a liquor standing at 15° Tw. will be obtained.

Into sufficient of this the silk is entered, worked well for one hour, then allowed to steep over night.

The next day it is wrung out, rinsed well, and passed through a bath made by diluting 1 lb. of silicate of soda with sufficient water; after wringing and rinsing, it is ready for the dye-bath.

The quality of the water used in the dye-bath has some little influence on the tone of the shade produced. Calcareous or limy water gives the best results, and where this is not obtainable it is necessary to add either acetate of lime or chalk to the dye-bath, using about 3 to 4 ozs. for every 100 gallons of water.

The grade or brand of Alizarine used also has some influence on the shade ultimately produced. The G shades of Alizarine (flavopurpurine) yield the most scarlet tones, and are best adapted for scarlets and pinks; the V shades (alizarine) yield the bluest shades, and are mostly used for dyeing reds and violets; the R shades (iso- or anthra-purpurine) are somewhat intermediate in shade.

Besides reds, Alizarine can be used for dyeing violets and chocolates. For violets an iron mordant is used; the silk is worked in a bath of nitrosulphate of iron at 28° Tw. for half-an-hour, it is then taken out, wrung, rinsed lightly, and passed into a bath of soda crystals to fix the iron. For pale shades of violet one treat-

ment by this process is sufficient; for deep shades the silk should be treated four times; for intermediate shades two or three times, a good rule being to allow one operation or treatment for each 5 per cent. of Alizarine used. After mordanting, the silk is dyed with Alizarine as described above for red, the violet or blue shades of Alizarine being used; from 2 to 5 per cent. being used for pale violets, 6 to 10 per cent. for medium shades, and 15 to 20 per cent. for deep shades. The violets so obtained are not remarkable for brilliancy of tone, being rather dull, but they are fast.

Chocolates can be dyed with Alizarine by mordanting with a mixture of alum and nitrosulphate of iron; by varying the proportions of the two mordants a variety of red or blue shade chocolates can be obtained.

After dyeing either violets or chocolates, the silk can be softened by boiling in soap, and then brightened with acetic acid as described for reds.

The processes described above for dyeing silk reds are equally applicable to wild as to cultivated mori silks.

DYEING SILK ORANGE AND YELLOW.

The number of yellow and orange colouring matters used for dyeing silk are tolerably numerous, although not so large in number as the reds. They are derived from both natural and artificial sources. Of late years the tendency has been to discard the use of the natural yellows because of their want of brilliance and permanency, and to make more extensive use of the

artificial yellow colouring matters, which are at once more brilliant in tone, easier to apply, and in many cases faster to light and air.

1. With Natural Yellow Colouring Matters.

These are not numerous, comprising annotto, Persian berries, fustic, weld and turmeric. Of these weld is the most important as it yields yellows faster to light and air than the others.

Weld Yellows.—A decoction of the dye-stuff is made by boiling 4 lbs. of weld with 3 ozs. pearlash, in sufficient water for about two hours, after straining, using the clear decoction. Alum is the mordant for weld, and it may be applied, first, by steeping the silk for two hours in a solution of alum at 6° Tw., then dyeing the silk in a decoction of the weld prepared as above described. The temperature need not be higher than 100° to 120° F. The quantity of weld used varies with the shade required, 2 lbs. for pale, 4 lbs. for dark colours for each 10 lbs. of silk. If a little soap is added to the dye-bath it insures greater evenness in dyeing. After dyeing, the silk is worked for ten minutes in a bath of acetic acid to brighten the shade and give lustre and scroop to the silk. For very deep shades 6 to 7 lbs. of weld per 10 lbs. of silk may be used. If pure shades are required care should be taken that the weld decoction is only made with the flower portion of the stem; the roots contain a little tannin which darkens the colour and destroys the purity of the yellows it gives. Instead of previously mordanting with alum, the latter can be

added to the dye-bath at once, using 4 to 6 ozs. alum to 10 lbs. silk. After dyeing, to give the silk brightness, wash and work the silk in a weak soap-bath containing $\frac{1}{2}$ lb. of weld, at 150° F., for half-an-hour, wash, and pass into an acetic acid bath to give lustre and scroop.

Fustic Yellows.—Fustic is rarely used now in dyeing yellows on silk, as the shades it gives are not very brilliant, and not very fast. Its chief use is in producing shades of greens, olives and browns. Alum is the mordant for fustic, and it can be applied either separately or in the dye-bath with the fustic, as in weld dyeing. The dyeing is done at a temperature of 120° to 150° F., using 1 lb. of fustic and $1\frac{1}{2}$ lb. of alum to 10 lbs. of silk for light yellows, and 8 lbs. of fustic for deep yellows, intermediate quantities for intermediate shades. Fustic extract may be used from $\frac{1}{10}$ lb. to 1 lb. for pale to deep shades. After dyeing, the silk is brightened by passing through a bath of perchloride of tin at 4° Tw., and washing well.

Quercitron Bark, like fustic, has almost gone out of use for dyeing yellows on silk. It may be dyed in the same way, or in a bath containing, for 10 lbs. of silk, 4 lbs. of bark made into a decoction, 2 lbs. alum and 1 pint of muriate of tin, dyeing at 150° F. for one hour. Light drabs are dyed with bark, using 1 lb. for 10 lbs. of silk.

Persian Berries are rarely used for dyeing silk; they give orange shades of yellows, using muriate of tin as a mordant. For 10 lbs. silk, dye in a bath at 150° F., with 3 lbs. Persian berries and 1 quart

muriate of tin; various shades can be got by altering the quantities of dye-stuffs used.

Annotto is largely used for dyeing orange shades on silk, and also for obtaining compound shades with indigo extract, logwood, etc. Annotto liquor is made by taking one gallon of boiling water, 2 ozs. pearlash, and 2 lbs. annotto, stirring altogether till dissolved. Silk is dyed with annotto in a soap-bath, using as much of the above liquor as is required to produce the desired shade. The dyeing should be done as quickly as possible; after dyeing the silk is washed and dried. For pale shades 120° to 150° F., and for deep shades 180° to 200° F. are the best temperatures to work at.

Turmeric is occasionally used for dyeing yellows on silk, using 4 lbs. to 10 lbs. of silk, dyeing in a plain bath at 150° F., no addition to the bath is necessary; 4 lbs. gives deep orange yellows, 1 lb. pale yellows. Tin salts added to the bath turns the shade more orange. Boiling spoils the shade. A little acetic acid may be added to correct any alkalinity of the bath, but such addition is not necessary.

All the natural yellow colouring matters have, to a great extent, given place to the aniline and coal tar yellows, which give more brilliant dyes and greater variety of shades, and are generally faster to light, acids, washing, etc.

2. Dyeing Silk Yellow and Orange with the Coal Tar Colours.

The yellow and orange coal tar colours are numerous and important, they dye all shades, from a reddish

orange to a pale lemon yellow; they can be classified in the same manner as the reds. They are brighter, give on the whole faster tints, and are easier to dye than the natural yellow.

(1.) *Neutral Yellows and Oranges.*—These include Chrysamine, Hessian yellow, Brilliant yellow, Chrysophenine, Diamine yellow N, Titan yellow, Mikado orange, Congo orange R, Benzo orange R, Primuline. They are dyed very much in the same way as the neutral reds. Chrysamine, Hessian yellow, Brilliant yellow, Benzo orange R, Congo orange R, are dyed in a soap-bath ($2\frac{1}{2}$ per cent.) with either sulphate or phosphate of soda (10 per cent.), from 1 to 3 per cent. of the colouring matter gives deep shades. Chrysamine, and the other yellows give shades of orange yellow, fairly fast to light but not to soaping, the last two reddish oranges. If necessary, after dyeing, the shades can be brightened in a weak acetic acid bath. Chrysophenine can be dyed in the same way, or in a soap-bath with a little acetic acid, it gives bright yellows, fast to light and washing. Titan yellow can be dyed in a 20 per cent. salt bath with a little acetic acid, 2 per cent. of dyestuff is sufficient for full shades. Primuline in the same way; these give greenish yellows. The Mikado oranges are best dyed in a soap-bath, with a little acetic acid, about 7 per cent. of colour is required, and orange tones are obtained, very brilliant and pure, varying according to the brand of dyestuff used. All the yellow colouring matters are pretty fast to light, and resist soaping very well, especially Chrysophenine and Titan yellow; the others are slightly reddened, they resist acids very well, but not

alkalies, which redden them. The Mikado oranges are fairly fast to acids, the others are turned bluish, but they are fast to soaping and alkalies, although only moderately fast to light. These colours are very useful for dyeing mixed silk and cotton, or silk and wool fabrics. They may be mixed with the neutral reds, blues and browns, for producing compound shades of olives, greys, etc.

(2.) *Basic Yellows.*—These are not numerous, and consist of Phosphine, Auramine, Benzoflavine, Thioflavine T, Chrysoidine, Quinoline yellow, Acridine orange. They are dyed exactly in the same way as the basic reds (which see). Phosphine (5 per cent.) gives deep bright orange shades, and by using 2 to 3 per cent. will be found useful in dyeing what are called old gold shades. Auramine (3 per cent.) gives greenish yellows very fast to light and soaping; it is not much used for silk dyeing, as it does not take easily to the fibre. Benzoflavine, orange or chrome yellows; Thioflavine T, greenish yellows, pale tints have a peculiar greenish bloom that is very fine and give it special value to the silk dyer, deeper shades approach nearer a chrome tint. Chrysoidine (1 to 2 per cent.) gives fine reddish oranges, fairly fast. Quinoline yellow gives greenish yellows very fast. Acridine orange N O (1 per cent.) gives orange shades, bright but not fast to soaping. The basic yellows may be mixed with the basic reds, greens, etc., for the production of compound shades.

(3.) *Acid Yellows.*—These are very numerous, and, like the reds, belong to two distinct groups, the acid yellows and azo yellows and oranges. The *acid*

yellows are almost exclusively nitro compounds, and include Picric acid, Napthol yellow, Napthol yellow S, Aurantia, Citronine (Brooke, Simpson and Spiller). These are all dyed in acid baths (see acid reds). Picric acid gives greenish yellows, 1 to 2 per cent. being sufficient for deep shades. Napthol yellow and Napthol yellow S, with 2 to 3 per cent. of colouring matter give bright chrome yellows, fairly fast. Aurantia is a colouring matter almost entirely used for silk dyeing, and it gives orange yellow to orange shades with from 1 to 3 per cent.; for old gold shades it is extensively used; it is fast to light but not to acids or alkalies. Citronine gives gold yellow shades.

The *Azo Yellows and Oranges* are very numerous, and include the Oranges, Croceine orange, New yellow, Tartrazine, Acid yellow. It is not necessary to describe these in detail; they are dyed in exactly the same way as the azo reds (which see). Some examples of their use will be found in the Appendix.

(4.) *Adjective Yellows.*—There are three colouring matters belonging to this group, viz., Alizarine orange, which gives bright orange shades, Galloflavine, and Gambine yellow, which dye yellows fairly bright on silk. They are dyed by the same process as the Alizarine reds. Alizarine orange gives fine oranges of a yellow tone with an alum mordant, using about twenty per cent. of dyestuff; with three per cent. a salmon orange is obtained. With an iron mordant a deep maroon is obtained. Galloflavine and Gambine yellow require a chrome mordant; this is best applied as described under Alizarine black, page 52, from chrome acetate. Galloflavine gives greenish yellow

tints, Gambine yellow orange yellow tints. They are fast colours.

Dyeing Blue on Silk.

Until the advent of the coal tar blues, the only blues a silk dyer could use was Prussian blue, which was developed on the fibre, and indigo. The former was rather troublesome to produce, although fast to light, and a moderate amount of washing. The latter is difficult to apply in one form, and fugitive when used in the other although easy enough to dye with. With the advent of the coal tar blues the silk dyer had placed at his disposal the means of producing a greater variety of blue tints than he could possibly produce with the old dyestuffs, and tints which are more satisfactory in every way, more brilliant, faster to acids, washing and light.

1. From Natural Colouring Matters.

The only natural colouring matter used to dye blue on silk is indigo. This body is applied in the dyeing of fabrics in two ways known as the "vat method" and the "extract method." The "vat method" consists in the treatment of the indigo with reducing agents, such as copperas and lime; zinc and bisulphite of soda or hydrosulphite of soda, whereby a solution of indigo is obtained, into which the fabric to be dyed is entered, taken out, wrung and exposed to the air, by the oxidizing action of which the indigo blue gradually develops on the fabric. In the second or "extract method," the indigo is first dissolved in strong sul-

phuric acid, which is then neutralized by soda and "Indigo extract" is obtained, a body readily soluble in water and used in dyeing much in the same way as the acid coal tar colours. The vat method is the process exclusively used in dyeing cotton, wool can be dyed by either method. In dyeing silk the vat method is very rarely used. It gives the fastest shades, the conversion of indigo into extract seems to destroy its permanent qualities.

There are several ways of applying indigo extract in silk dyeing, the simplest is to make a large bath with about 1 per cent. of sulphuric acid and the dye-stuff, working at a temperature of from 110° to 130° F., or, if necessary, at higher temperature. The shade obtained necessarily depends upon the proportion of dye-stuff used; 2 per cent. of indigo extract will give pale shades; 5 per cent., medium shades; 10 per cent., deep shades, the tone of blue obtained being greenish. The indigo extracts of different makers vary much in their colouring power.

A method frequently adopted is to mordant the silk with alum, by steeping for twelve hours in a bath of 20 to 25 per cent. of alum; then to dye in a bath containing the required quantity of extract with about 5 per cent. of alum, at a temperature of 150° to 180° F. This method is chiefly adopted when indigo is combined with such colouring matters as cochineal, fustic, quercitron or Persian berries to form compound shades such as greens, greys, drabs, browns, etc.; in which case the alum acts as a mordant for the other colouring matters which are added to the dye-bath. For these compound shades indigo

extract has been replaced by induline to a large extent.

2. Artificial Blues.

(A.) *Prussiate Blue.*—Prior to the advent of the coal tar blues, the only other blue dyed on silk was the prussiate blue. The process is as follows:—For 10 lbs. silk. Enter into a bath containing $2\frac{1}{2}$ pints nitrate of iron, 120° Tw. in from 10 to 15 gallons of water, heat to 120° F., enter the silk, work about 10 to 15 minutes; lift, wring, wash, enter the still wet silk into a bath of $\frac{1}{2}$ lb. yellow prussiate (ferrocyanide) of potash and $\frac{1}{2}$ lb. sulphuric acid, work for 10 minutes, lift and wash. Then re-enter into the nitrate bath, work as before; after washing, enter into the prussiate bath. Then prepare a new bath with $\frac{3}{4}$ lb. nitrate of iron and $\frac{1}{2}$ lb. tin crystals, work the silk in this for 10 minutes, lift, wash, pass into the prussiate bath for 10 minutes, lift, wring, expose to the air for six to eight hours, wash and dry. The shade of blue obtained depends upon the number of workings in the respective baths; the above routine gives a medium shade of blue; by reducing the number of baths paler shades can be got; darker shades are obtained by increasing the number of workings, and omitting the tin crystals. Prussiate blues are fairly fast to light and acids, but not to excessive soaping or alkalies, which turns them brown red. What is called a Saxon blue is dyed as follows:—Work the silk (10 lbs.) in a cold bath of nitrate of iron at 6° Tw., for one hour, lift, wash and immerse in a cold bath of yellow prussiate (2 lbs.),

work for 20 minutes, lift, add 1 pint of sulphuric acid to the bath, re-enter the silk, work another 20 minutes, lift, wash, and dry. Prussiate blues are rarely dyed now.

(B.) *With Coal Tar Blues.*—These are fairly numerous, and many of them give very fine, beautiful shades, not obtainable from other blue colouring matters. Representatives of every class of coal tar colours are to be found among the blues.

The Neutral Blues. — These include the Benzo-azurines, Brilliant Azurine, Diamine Blues, Azo Blue ; they are not very satisfactory dyes for silk. Dyed in a soap-bath, with a very little sulphuric acid, and about 3 per cent. of colour, they give rather red, dull shades of blue. Dyed in the same way as the other neutral colours in a neutral bath, they give dull shades of grey. The only way to get good results from these neutral blues is to dye them in a bath containing borax, with a little alkali blue, raising the colour afterwards with a little acid. See Appendix for dyed patterns.

Basic Blues.—Of these there are two kinds, the Alkali or Nicholson blues, which are dyed by a special process, and the basic blues proper, Meldolas blue, New blue, Nile blue, Basle blue, etc. These last are dyed in a soap bath, or in a bath containing Glauber's salt. They give very fast, deep shades of blue. Nile blue gives the greenest shade of any of this class of blue. New blues are of different shades.

Alkali blues, or Nicholson blues. These are dyed on silk by a special process, different from that adopted with any other blues. The dye-bath is made

with 5 to 10 per cent. of borax, and the necessary amount of colour. The silk is entered into the dye-bath at a temperature of 160° F., and worked at this for a quarter of an hour, the bath is then heated to the boil and kept at this heat for three-quarters of an hour; the silk is taken out, wrung, washed in water, and the colour raised by passing into a cold bath of water, acidulated with sulphuric acid. The colour is developed, afterwards the silk is washed and dried. The dye bath is not exhausted, and may be used again, half the quantities of borax and colour being added for each succeeding lot of silk. The acid bath can also be used repeatedly by adding a small quantity of acid from time to time. As there are many shades, varying from reddish-blue to pure blue, of alkali blues, care should be taken to keep both dye and acid baths for the same shade of blue; if this is not done the dyer will never be sure of obtaining the same shade of blue in different dyeings of his silks. To ascertain how the dyeing is progressing in the dye-bath, the dyer may take small samples out and dip them in the acid bath and note the shade that is developed; if this is not deep or solid enough the dyeing is continued; if it be right, then the main bulk of the silk is taken out of the dye-bath and passed into the acid-bath. The process should be modified according to the quantity of blue employed; this varies much with different makes, some require but little borax, others a good deal; this depends upon the alkalinity of the sample of blue, and to obtain good results with a particular batch of colour, the dyer should make a few preliminary ex-

periments to ascertain the proper proportion of borax to use, too much is not good as tending to produce weak shades. Alkali blues may be compounded with acid colours, like the scarlets, oranges, etc. The method consists in first dyeing the blue in the usual way, then entering the siik in a bath containing the other colouring matter. The blue is developed at the same time as the second colour is dyed on the silk, the results cannot be considered so satisfactory as those which may be produced by using the direct acid blues, partly because there is not that complete control over the shade produced which is desirable in dyeing. The various shades of alkaline blues are distinguished by the brands RR, B, BB to 6 B, etc.

Acid Blues.—The acid blues are dyed on silk either in a soap-bath broken with sulphuric acid, or in a bath containing Glauber's salt and sulphuric acid. In this way may be dyed China blue, Soluble blue, Crystal blue, Night blue, Navy blue, Cotton blues; under these names comes into the market a number of blues of different shades, from reddish R R to pure blue 6 B, which are the sodium salts of the di- and tri-sulphonic acids of the rosaniline blues; they give a variety of very fine and brilliant shades, moderately fast to light; in this they vary very much, the more soluble the blue is, the more fugitive it becomes (as with Cotton blues); they stand soaping or washing very well. The Spirit blues, the true Opal Blues, are the pure rosaniline blues; they are insoluble in water, and require to be dissolved in spirit, they are dyed with a little acid in the bath, and give, like the blues above-named, various shades from a red to a pure

blue, fast to washing, dilute acids and light. Induline blues are most valuable to the silk dyer, not only for dyeing deep shades of blue very fast to light, acids and washing, but because they can be compounded with other colours to form a great variety of useful shades, greys, olives, drabs, etc. Napthol black 3 B may be mentioned here because of its giving very fine navy blues, especially if a little Induline is added to brighten up the shade. Victoria Blue B is a very fine blue, and dyes silk easily in acid baths.

Alizarine Blues are dyed on silk by the same process as alizarine reds. Alizarine Blue GW gives with alum mordants fairly bright blues, using 20 per cent. of dyestuff, with 3 to 5 per cent. very good useful lavender shades can be obtained, while with 1 to 2 per cent. silver greys are obtained. With an iron mordant deep shades of navy blue are obtainable. Alizarine blue R dyes duller and redder shades than the GW blue with an alum mordant; with an iron mordant the shades are very dark blue, almost approaching a black.

Alizarine Cyanine dyes silk mordanted with acetate of chrome fairly well, giving bright blues very similar to those obtained with Alizarine Blue. This new dyestuff is made in several brands, and as yet has not come into extensive use for silk dyeing.

Dyeing Green on Silk.

Greens are among the most important colours that the dyer has to produce; their variety is very great, varying as they do from a very pale sea-green tint

through every shade of yellow-green, green, blue-green, to sad shades, such as olives and sages. Their production requires a great amount of practical skill and knowledge on the part of the dyer, as in very few cases can the greens be produced from a single colour, but they have to be obtained by combining several colours; and in the art of combining these in the easiest and best manner to produce the required shade lies the art of the expert; such art cannot be obtained except by constant practice, close observation, and knowledge of colours, both in the abstract and concrete.

I. FROM NATURAL COLOURING MATTERS.

No natural green colouring matter capable of dyeing green on silks is known, and any greens dyed with natural colouring matters are produced by mixing blues and yellows together. A green can be got with indigo and weld, or indigo and Persian berries, or indigo and fustic. The silk is first prepared for dyeing the yellows by mordanting it, then it is dyed with the yellow and then the indigo or the two dyestuffs may be used in the same bath; only olive shades of green are thus obtained.

A fairly good green can be obtained as follows: For 10 lbs. silk. Prepare a bath containing 1 lb. of alum in a gallon of water, using as much of this as will enable the silk to be freely handled; allow to steep three or four hours, lift and wash well. Then enter into a decoction of 6 lbs. fustic at about 170° to 180° F. for thirty minutes, lift, add 2 ozs. indigo extract to this bath, re-enter the silk, work thirty

minutes longer, lift, wash, and dry. Finish the silk in the usual way. The production of the same shade cannot always be depended upon, as the strengths of the fustic and indigo extract vary from time to time, the dyer must make allowances for this, and alter his quantities as experience dictates.

Another method is to treat the silk in a decoction of 4 lbs. fustic at 170° to 180° F. for forty minutes, then lift, and add 1 lb. alum and 2 ozs. indigo extract, re-enter the silk, and work to shade.

A bottle-green can be got by mordanting the silk (10 lbs.) in a bath of 2 lbs. alum and 1 lb. copperas, for one to two hours, washing, then working for half-an-hour in a decoction of 6 lbs. fustic ; lift, add 2 ozs. indigo extract, re-enter the silk and work twenty minutes longer ; wash and dry.

Olive-green : 1st, dye same as the fustic green, using 1 lb. of logwood, and 6 lbs. fustic. 2nd. Treat the silk for half-an-hour in a bath of 1 lb. copperas and $\frac{1}{4}$ lb. alum, wash, dye in a bath of 2 lbs. fustic and 4 ozs. logwood for half-an-hour, shading with a little indigo extract if necessary.

2. FROM COAL TAR COLOURS.

These are nearly all of the basic class, there are a few acid colours and one adjective colour.

Basic greens, such as Malachite green, Methyl green, Brilliant green, Azine green, are dyed in the same way as the basic reds ; they are all strong colouring matters, one per cent. being usually sufficient to give deep shades, Azine green gives very deep blue shades ;

the others more or less blue-greens very fine and brilliant. By adding more or less Auramine or Benzo-flavine, a great variety of shades of yellow-green can be obtained by varying the proportions of the green and yellow dyestuffs. The shades obtained are fairly fast to dilute acids, washing, and moderately fast to light. By adding Bismark brown in various proportions olives and sages may be obtained. A little Indazine M or Induline gives peacock greens.

Acid Greens.—Acid green, Fast green, Guinea green and other acid greens are dyed either in a soap-bath, or in old boiled-off liquor broken with acetic or sulphuric acid, or they may be dyed in a bath containing Glauber's salt and acid; the temperature of the dye-bath is best at from 170° to 180° F. The shades obtained are rather bluish in tone, by shading with any of the acid yellows, pure green, or yellowish green shades can be obtained, according to the relative proportions of the two dyestuffs. By shading with acid browns, olives and sages are obtained, adding induline gives peacock greens. The shades so obtained are fast to dilute acids and washing, and moderately so to light. Napthol green B, dyed with Glauber's salt and tartaric acid using six to eight per cent. of dyestuff, gives fine olive shades of green fast to washing and light.

Adjective Greens.—At present only a few adjective greens, are known. Cæruleine, or Anthracene green, as it is sometimes called, can be dyed on alum mordanted silk when it gives moderately bright shades of green, using 20 per cent. of dyestuff; with 2 to 3 per cent., useful shades of sea-green are obtain

able. With iron mordants this dyestuff gives a black. The shades obtained are fast to light, washing, and acids.

Gambine R and Y and Dioxine give greens when dyed on iron mordanted silk; these are somewhat dull, but are fairly fast to washing and light.

Dyeing Browns on Silk.

Brown shades vary very much in tone from yellow brown to red brown; they can be obtained from both natural and artificial colouring matters.

1. From Natural Colouring Matters.

Browns are not easily obtained from natural colouring matters: very good fast browns of a slight reddish tone can be got from cutch. The silk (10 lbs.) is steeped in a decoction of $\frac{1}{4}$ lb. cutch for five hours at about 100° F.; then it is worked in a bath of bichromate of potash at 130° F. for half-an-hour to develop the shade.

Another method is to steep the silk in a bath of alum, $\frac{1}{2}$ lb. to 1 gallon, from six to eight hours, or over night. Then, after washing, dye in a bath containing 20 ozs. each of logwood, brazil-wood, and fustic, at a temperature of 180° to 190° F., from thirty to sixty minutes, till the shade is developed. By varying the quantities and the proportions of the dyestuffs various shades, from a yellow to a red brown, can be obtained; a predominance of fustic makes the yellower shades, of brazil wood, the redder shades, while logwood tends to turn the shade slightly bluer.

2. From Coal Tar Colours.

Every class of colours are found among the coal tar browns, and these have almost completely displaced the natural colouring matters for dyeing browns on silk.

(1.) *Neutral Brown Dyes.*—These include Benzo-brown, Congo brown, Hessian brown, Mikado brown, Titan brown. These are used either in a soap or salt bath, and a great variety of shades can be obtained from red to yellow browns. Benzo-brown NBX and Mikado brown M, gives dark warm browns of a yellow shade, being in fact true browns. These shades are fairly fast to washing, acids and light. Congo brown G gives a yellow brown, the others give reddish browns, and are usually bright and full, but are not fast to light, although as a rule they resist soaping. Titan brown, Benzo-brown 5 R and Congo brown R will be found useful for dyeing terra-cotta reds.

(2.) *Basic Brown Dyes.*—Bismark brown is the only representative of this class; it dyes reddish shades of browns on silk, bright and full, fairly fast to acids, washing, and light.

(3.) *Acid Brown Dyes.*—Acid browns are the representatives of this class of colours. They give reddish browns, and are fast to acids, washing, and moderately so to light. By shading with a little induline dark browns are obtainable.

(4.) *Adjective Brown Dyes.*—There are few colouring matters of this class, viz., Anthracene brown, or Alizarine brown, as it is sometimes called, Gambine R and Y and Dioxine; they can be dyed on silk by the

same method as the Alizarine black, with a chrome mordant. Anthracene brown gives dark-brown shades with chrome; on an alum mordant it gives reddish shades using 20 per cent. of dyestuff; with 2 to 3 per cent. fawn brown tints are obtained. Gambine R and Y and Dioxine with the chrome mordant give reddish browns. By shading with Alizarine black or Alizarine blue warm shades of brown can be obtained.

Violet Colours on Silk.

Before the discovery of the coal tar colouring matters, no natural violet colours could be produced, and though a kind of purple was got from logwood the results were not good. The introduction of the aniline purples and violets enabled dyers to produce shades remarkable for their brilliancy and purity which were previously unattainable by any means.

Purple from Logwood.—A rather reddish shade of purple, of no great brilliance, can be got from logwood by first mordanting the silk with alum in the manner described under Alizarine reds, and then dyeing with a decoction of logwood.

Purples and Violets from Coal Tar Colours.

1. *Neutral Violets.*—There are only a few of these, Hessian violet, Diamine violet N, Azo-violet. The results on silk are not good, very reddish shades of no great brilliance being produced.

2. *Basic Violets.*—These are numerous, and range in shade from a red violet (purple) to a pure violet; they include Regina purple, Hofmann's violet, Paris

violet, Methyl violet, Benzyl violet; the different shades being distinguished by the marks R R, 3 R, R, B, B B, 3 B, 5 B, 6 B. They are dyed by the same processes as described under basic reds, and are strong colouring matters, with a great affinity for the silk fibre. The principal difficulty in using them is to get even shades; this can only be attained by using dilute baths, having plenty of Glauber's salt, or soap, or "boiled-off" in the bath, and working the silk well. By using from ¼ to ½ oz. per 10 lbs. of silk, lavender and lilac shades can be obtained. As a rule the violets are very brilliant, fast to washing and dilute acids, but not to light.

3. *Acid Violets.*—There are only a few of these. Acid Mauve B, Acid Violets, Fast Violet, Acid Violet N, Violamine B and 2 R, etc. These are dyed in a bath of Glauber's salt and sulphuric acid, or in an acidulated soap or boiled-off bath. Acid Mauve B, Violamine 2 R, give red shades which are very fine, Acid Violet N gives bright blue violet. The Acid violets are of various shades, from red to blue violets; Violamine B gives a violet, Fast Violet gives dark shades. As a rule these violets are fairly fast to washing and dilute acids but not to light.

4. *Adjective Violets.*—Gallein and Gallocyanine are the only representatives of this class; they give rather dull but fast shades; violet can be got from Alizarine by mordanting with iron, but the shades obtained are dull, although fast to light, air, etc

Modes, Drabs, Greys, and Compound Shades on Silks.

In the previous pages only the methods of dyeing with the simple colours are given ; these can of course be combined in various ways to form a great variety of compound shades ; in the Appendix will be found recipes and patterns showing in detail how to dye these compound shades.

CHAPTER V.

DYEING MIXED SILK FABRICS.

UNTIL lately silk was invariably dyed in the state of yarn; when the silk was to be woven into mixed fabrics such as satins, etc., it was impossible to dye both fibres exactly of the same shade. Such fabrics were woven with dyed yarns, care being taken to match the two yarns, warp and weft, as closely as possible. The weaving of dyed yarns of two fibres is open to the objection that when the fabric comes to be washed and finished, the various materials are apt to act differently on the two fibres, so that however closely they originally approximated in shade, there is a wide difference in them at the finish. When the coal tar colours were introduced more or less successful attempts were made to dye both fibres in a fabric at once; although very difficult, it was possible with the exercise of a considerable amount of care, to obtain good results and get a fabric of one shade. It was easier, however, to obtain two colour effects which were formerly with the old natural colours absolutely unattainable.

The introduction of the so-called benzidine colours, with the facility with which they dye all fibres equally

well by one process, has given an impetus to the dyeing of mixed silk fabrics in the piece, and the method is now greatly coming into use. The advantages of dyeing in the piece may be simply stated. In the process of weaving the cloth is very liable to get dirty, from various causes, such as oil falling on it from the loom, or dust settling on it; in the case of fabrics made from dyed yarns, this would dull their lustre, and necessitate a cleansing process, which is liable (as has been pointed out) to act differently on the two fibres and alter their shades. When the woven fabric is dyed in the piece, any cleansing that is required can be done before dyeing, so that after dyeing the piece only requires finishing, an operation which will not effect the colour in any way.

Dyeing Mixed Fabrics with Benzidine Colours.—There is scarcely any need to enter here into detail regarding the method of using this class of dyestuffs for mixed fabrics, as they are used in precisely the same way as for dyeing silk only, which has been already described. The best general method for applying them is to use from 20 to 25 per cent. of salt in the dye-bath with some colours, such as Titan Yellow Y, Chrysophenine, Erika—it is scarcely possible to add too much. As a rule the dyeing should be done under the boil; a plan often adopted is to raise the bath to the boil, turn off the steam, enter the goods, and work for one hour. Phosphate of soda and a little neutral soap, or Glauber's salt and neutral soap, are also good materials to add to the dye-bath.

This class of colours is now very numerous, but they are not all applicable for dyeing mixed cotton

and silk fabrics, because some few exceptions, especially the blues and violets, have such very different affinities for the different fibres, that their use cannot be recommended. Chrysophenine, Brilliant Congo, Deltapurpurine, Chrysamine, Titan Yellow Y, Titan Brown, Hessian Brown, Diamine Scarlet B, and a few others, work well and give even shades on both fibres. For dyeing mixed silk and wool fabrics all the colours are available, as they dye both fibres to almost identical shades.

The following details will be useful :

Red.—Use Benzopurpurine, Diamine Scarlet B, shading, if required, with Chrysamine, Benzo-azurine, etc. Dye in a soap-bath at the boil. Should the silk not come up in shade to the cotton, it can be brought up by a second dyeing with a basic colour like Magenta, Safranine, Rhodamine.

Orange.—Dye with Benzopurpurine and Chrysamine, or Benzo-orange R, Titan Orange, bringing up the silk to shade with a second dyeing, using Chrysoidine, Orange G, etc.

Yellow.—Titan Yellow, Chrysamine, Chrysophenine, give good results, using salt in the dye-bath.

Dark Blue.—Dye first with Benzo-azurine, then to correct the reddish tone taken up by the silk, give a second dye-bath with methylene blue or new green, using a little acetic acid to give the bath a weak sour reaction.

Olive.—Dye first with a mixture of Benzo-azurine, Benzopurpurine, and Chrysamine, bringing up the silk to shade wth Chrysoidine and Methylen Blue in an acid bath.

Brown.—Use Mikado Brown, Titan Brown, and Benzo-Brown N B X in a salt-bath.

Grey.—Benzo-azurine shaded with Chrysamine in the first bath, dyeing up the silk with New green, Induline, etc.

These methods are applicable to all mixed silk fabrics.

Dyeing Silk and Cotton Fabrics.

In dyeing such fabrics with the other classes of coal tar colours, the main points to be considered are, first, to dye the silk with colours which will bear soaping; then to dye the cotton with colours which while fast, or nearly so, to soap on the fibre, are not so fast when dyed on silk. It must always be borne in mind that the silk will take up some of this second colour and its tint be more or less altered thereby, and for this allowance must be made, for which experience is the only guide; the precaution can be adopted of dyeing the cotton at a hand heat, as at this temperature the silk is but little affected by the cotton colour. The following details for producing various shades and colours, may be regarded in the light of hints as to methods of working.

Blue from Alkali and Cotton Blues.—For light or medium blues on mixed silk and cotton goods, the following method gives good results:

The silk is first dyed in Alkali blue, using from 1 to 3 per cent. of colouring matter, according to the depth of shade required; various tones are obtained by using various brands of Alkali blues; the blue is dissolved in

either borax or carbonate of soda as described on page 91, dyeing at about 180° to 190° F., developing the colour afterwards in a weak sulphuric acid bath. For further details see page 92. After the Alkali blue has been properly developed on the silk, the fabric is ready for the dyeing of the cotton. This is effected by preparing a cold bath of tannic acid, using a liquor containing 5 lbs. of tannic acid in 100 gallons of water, and allowing about 1½ to 2 lbs. of tannic acid to 100 lbs. of material. The fabric is immersed in this for a period of from three to six hours, according to the depth of colour required; for very light shades one hour and a half is quite sufficient, for medium shades about four hours, and for deep shades six hours should be allowed. By adding fresh tannic acid to the bath to restore it to the original strength, which may be ascertained by the Twaddell if desired, it may be used again for a fresh batch. After the fabric has been in the tannin a sufficient length of time, it is removed, wrung, preferably, in a hydro-extractor, to remove surplus tannic acid, and then it is passed into a cold bath of tartar emetic, or some other antimony salt, containing from ½ lb. to 2½ lbs. in 100 gallons of water; for pale shades the smaller quantity is used, for deep shades the larger quantity; medium shades will take about 1½ lb. to the 100 gallons of water. In this bath it is allowed to remain about twenty minutes; after which it is removed, washed in water and is ready for dyeing, which is done in a cold bath of Cotton blue, a trace of sulphuric acid added to the bath prevents any deterioration of the colour of the dyed silk. To obtain level shades on both fibres it is

important to see that the Alkali blue used for the silk and the Cotton blue used for the cotton correspond in tone. It would not do to use a red shade Alkali blue and a blue shade Cotton blue, for instance. The silk should be dyed slightly paler than it is intended to be because it will take up some of the cotton blue; a slight experience will show how much paler the silk has to be to allow for this deepening of the shade in the second dye-bath.

Another method of dyeing pale blue shades on this class of silk goods is to cleanse the fabric as usual, then enter into a tannin bath to mordant the cotton; fix in an antimony bath, and dye with Methyl blue at a hand heat. Wash and brighten with acetic acid.

Dark Blues may be dyed with Indulines by first "tanning" the cotton, and then dyeing both fibres in a bath of Induline at from 130° to 140° F.

Pale Green.—The silk is first dyed green with New Green, Methyl Green, Brilliant Green, shading these if necessary with Auramine, Benzoflavine, Thioflavine T, or other similar dyestuff. The dyeing is done at about 120° F., in a slightly acid bath, the fabric is washed, "tanned" to mordant the cotton, which is then dyed with any basic or tannic greens, shaded with basic yellows. The cotton is mordanted and dyed cold.

Violet.—This colour can be produced by dyeing the silk first with Methyl Violet shaded with Acid Magenta in a soap or old boiled-off bath; washing, "tanning" the cotton and dyeing with Methyl Violet and Safranine to shade.

Red is dyed with Magenta or Safranine shaded with

basic yellows for scarlets by the process described for greens.

Olive.—Pale olive. Dye the silk with Induline, shaded with Archill substitute, Orange G, using sufficient to produce the desired shade, usually from $\frac{1}{8}$ to $\frac{1}{4}$ per cent. of Induline and half the quantity of the other colours is sufficient. The dyeing is done in a weak acid bath, at from 100° to 120° F. After washing, the goods are "tanned" and dyed with New Blue and Chrysoidine in a neutral bath at the ordinary temperature.

Dark and Medium Olives.—These are obtained by dyeing the silk as above rather darker than for pale olives, then give the cotton a strong "tannin" bath, and pass through Nitrate of iron; dye with New blue and Chrysoidine, and revive with acetic acid. Considerable care will be needed to obtain satisfactory results.

Black may be dyed on silk and cotton fabrics by almost any of the processes described above, page 35, for silk with the exceptions of Alizarine, Napthol and Napthylamine blacks. Aniline black will give good results. Very good results can be obtained by dyeing the fabric with 7 per cent. of Napthylamine black and 7 per cent of Diamine Black R O with 1 per cent. of Thioflavine S to shade it, adding salt and a little acetic acid to the bath. The Napthylamine Black dyes the silk, and the Diamine black the cotton, the shade obtained being nearly the same on both fibres.

Rose can be produced very satisfactorily by "tanning" the fabric and dyeing in an acetic acid bath of Rhodamine.

It is much easier to dye mixed silk and cotton fabrics in two colours, for instance, the silk red and cotton green, or the silk green and cotton blue than in self colours. Some very pleasing effects may thus be obtained. It is not necessary to do more here than to say that the silk should be dyed first with acid colours, the cotton being then "tanned" and dyed with basic colours in the cold or at a gentle heat, so that the silk may take up as little of the second colour as possible. After the dyeing the goods are lightly soaped, to remove as much as possible any of the second colour that the silk may have taken up, after which the silk may be brightened, if required, by a weak bath of acetic and sulphuric acid. See the Appendix for examples.

Dyeing mixed Silk and Wool Fabrics.

This dyeing may be in a self colour or of two different colours or shades. The former is the more difficult as the fibres have rather different affinities for the various colouring matters.

Self colours.—The azo colours will, as a rule, be found to give the best results, the basic colours also dye well; Alizarine dyes equally well on both fibres, Alkali blue for blues, Napthol black and Napthylamine black for navy blues and blacks, Napthol green for greens, Acid magenta for reds can be used with success. Some of the yellow and red direct dyes such as Titan yellow, Chrysophenine, Brilliant congo, Deltapurpurine, Diamine brown, etc., are also available and dye easily; the blues of this class do not dye well.

Dyeing in Two Colours.—Mixed silk and wool fabrics may be dyed in two colours, thus producing some very pleasing effects. This double dyeing may be done either in one, or in two, or more baths; the latter gives the most satisfactory results. The following are some of the effects which may be obtained:

1st Process. Dyeing in one bath at the boil, with the addition of a little sulphuric acid, washing, soaping slightly in the cold, and brightening with acetic or tartaric acid.

The silk is dyed:	The wool is dyed:	The bath contains:
Rose.	Red.	Phloxine 1 %.
Silver grey.	Blue.	Indigo extract 5 %.
Yellowish brown.	Deep bluish red.	Chrysoidine, Azoflavine, and Acid magenta.
Greyish red.	Blue.	Magenta and Indigo extract.
Brown.	Olive.	Acid yellow, Indigo extract, Orange G.
Rose	Red.	Acid magenta.
Yellow.	Brown.	Acid yellow, Acid magenta, Auramine, Indigo extract.
Blue.	Brown.	Malachite green Methyl violet, Magenta, Acid yellow, Indigo carmine.

2nd Process. Dyeing in two baths. The first bath dyes the wool chiefly in an acid bath at the boil, the second bath is used cold, with the addition of a small quantity of acid, and dyes the silk. In the first bath acid colours are used, and these are taken up by both fibres, but mostly by the wool; in the second bath

basic colours are used and dye the silk chiefly, although the wool will take up some of the colour.

The silk is dyed :	The wool is dyed :	The dye baths are made with : (1st bath)	(2nd bath)
Blue.	Red.	Acid magenta.	Aniline blue.
Green blue.	Green yellow.	Napthol yellow S.	Aniline blue.
Violet.	Bronze.	Acid yellow.	Methyl violet.
Green.	Yellow.	Acid yellow.	New Victoria green.
Greenish yellow.	Green.	Light green S.	Auramine.
Violet.	Violet red.	Acid magenta.	Nigrosine.
Lilac.	Green.	Light green S.	Safranine.
Green.	Olive.	Acid yellow.	Safranine & soluble blue.

3rd Process. The wool is dyed in an acid bath, the fabric is soaped at the boil, washed, and the silk dyed in a cold bath as before. The following are some of the results which may be obtained :

The silk is dyed :	The wool is dyed :	The dye baths are made with : (1st bath)	(2nd bath)
Red.	Yellow.	Napthol yellow S.	Safranine.
Yellow.	Red.	Acid magenta.	Auramine.
Blue.	Green blue.	Acid green.	Aniline blue.
Red.	Violet.	Acid violet 6 B.	Safranine.
Blue.	Red.	Scarlet 2 R.	Aniline blue.
Blue.	Red.	Acid magenta.	Methylene blue.

CHAPTER VI.

SILK PRINTING.

PRINTING on silk has never been practised to the same extent as printing on cotton, for reasons which are rather difficult to formulate. Probably fashion has exercised a deterrent influence in this direction, and moreover, with the natural colouring matters, silk and wool do not so readily adapt themselves to the processes which have to be employed as cotton. The introduction of the coal tar colours with their simpler method of procedure, has, however, brought silk printing into greater prominence, and there is no doubt a future before it which only requires developing to bring it into favour.

Silk printers must, however, turn over a new leaf if progress is to be made. They are too conservative, and regard their business too much in the light of a trade secret, and businesses which are carried on in this way as a rule never progress. There are trade secrets and trade secrets. On the one hand, we regard them with favour when they are some special processes discovered by the users who ought to have the benefit of their invention. On the other hand, there are so-called trade secrets which are not secrets at all,

but are really common property, although many users of such consider that they are secrets. Whether one person or twenty knows such will make no difference to the prosperity of a particular firm, but if all new comers are to find them out for themselves by experience, the time and expense of gaining this experience is really wasted. This condition of things will not be remedied until there is a freer interchange of ideas between silk printers and dyers.

In the following pages the general principles which underlie the operations of silk printing will be described rather than any specific recipes given for the production of special shades as being likely, especially in the case of the coal tar colours, to be of more value than a collection of recipes.

Methods of Printing.—There are two methods in use for printing silk, viz., hand-printing and machine-printing. From a chemical point of view there is no essential difference between them; from a mechanical point there are some minor differences, disregarding the fact that machine-printing is cheaper than hand-printing, and is much more productive in the quantity of material capable of being turned out.

Hand or Block Printing.—In this method a wood block is engraved with the design in relief, points are arranged by means of which the printer can place the block in the proper position on the silk fabric. Without going very much into detail, the process of block printing may be briefly described as follows:—The piece of silk to be printed is stretched on a long, narrow table, which usually ranges about 15 to 20 feet long by 3 to 4 feet wide. This is covered by a blanket,

on the top of which the silk is spread. A shallow wooden box, mounted on legs and wheels, so that it can be readily moved from one end to the other of the table, forms the colour-box. This is supplied with the colour which is to be printed on the silk in the form of a thick paste. There is suspended in the colour-box a loose framework of wood, over which is stretched a piece of felt. This floats, as it were, on the colour, some of which passes through the felt, which acts as a strainer. The block is pressed on the felt and takes up some of the colour. This is now transferred to the silk, the printer by the gauge-pins on the block placing it in proper position on the fabric. By a gentle tap with the hand, or in the case of very large blocks by a mallet, the colour on the block is transferred to the silk. The block is now lifted off again, pressed on the felt to take up fresh colour, which is transferred to the silk as before. From time to time, by means of a spreader, the printer sees that the felt is covered by a uniform coat of colour. This process is a slow one, but the results, in the hands of a good and careful printer, are good.

Machine Printing.—Machine printing, although it has been in use in the calico printing industry for the last sixty years, is only just beginning to be used for silk printing. No matter how complicated a printing machine may appear, the principles on which it is constructed are simple, and a twenty-colour machine is really only a one-colour machine multiplied in its parts twenty times, just as in a piano there are many pieces of mechanism, yet one and all are copies of one another. The essential portions of a machine, no

matter whether it be for cotton, wool, or silk printing, consists of first an engraved copper roller on which the design is engraved in lines or dots, whichever is most convenient or necessary for the production of the particular effect aimed at. While in the block the design is engraved in relief, and the lines stand up from the body of the block, in the roller the design is engraved in lines sunk in the roller. This roller presses upon a large pressure roller, which is covered with a blanket, and which gives the necessary pressure to force the fabric against the engraved roller, and to cause it to take up the colour from the lines of the engraving. On the opposite side to the pressure roller is another roller covered with felt, called the furnisher roller, which revolves in a box, the colour box, containing the colour which is to be printed on the fabric. This furnisher roller takes up colour and transfers it to the engraved roller. A thin blade of steel, the "doctor" as it is called, presses against the roller, and scrapes off all superfluous colour from the surface of the roller. Fig. 13 is a diagrammatic representation of the working portions of a cloth printing machine, *a* is the pressure cylinder, which varies in size according to the number of engraved rollers; *b* is the engraved roller, the number of which in any one machine depends upon the number of colours to be printed at one time; *c* is the furnishing roller; *d* the colour box; *e* is the blanket; *f* the "back grey" as it is called, *g* the fabric being printed. As just mentioned, between the engraved and pressure rollers, to secure some elasticity which will force the fabric being printed into the lines of the design, there

is an endless blanket made of wool felt; other materials have been tried, but this material has been found to be the best. There is also a piece of grey cloth which is used more to keep the blanket clean from any surplus colour which might happen to pass through the printed fabric.

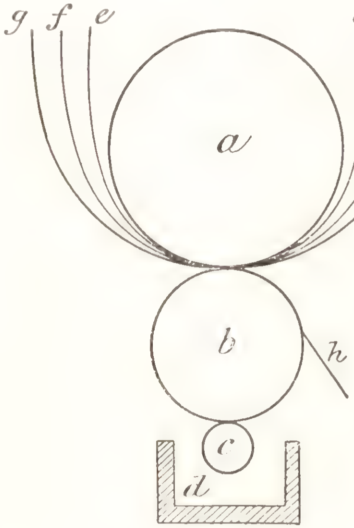


Fig. 13.

To obtain satisfactory results in block printing the principal points to notice are to have the colour of the right consistency, evenly distributed over the surface of the colour box, so that every portion of the block gets a uniform amount of colour on it, to see that the block is properly placed on the cloth, and that the pressure given to it to transfer the colour is the same

at every impression; all these points can only be learned by experience, the remedies in each case are obvious to any practical person.

In machine printing many more troubles crop up than in block printing. First there is the making, in multicolour work, the colours fit; this can only be done by seeing that the rollers are properly put on the mandrils, and in a proper position with regard to one another; no very definite rules can be laid down, but a few trials will soon show the printer how to shift his rollers to make them fit. One very important point is to see that the pressure on both ends of the roller is equal; if one end presses against the pressure roller more than the other end, the roller will not print evenly over its whole length—at one end the design will come up full and deep, at the other end thin and pale; this is remedied by a few turns of the pressure screws; the proper condition of the "doctor" is a matter of importance, the edge should be quite level and press equally against the roller along its whole length; if from some cause or another dents and scratches occur in it, then at these points the colour is not cleared off the roller, and streaks and stains on the cloth are the results; defects in the "doctor" generally show themselves in streaks along the length of the printed piece, and when such occur the "doctor" may be assumed to be at fault. The furnishing roller should be kept well supplied with colour, so that every part of the roller gets its proper share of colour. One difficulty which is met with in machine printing is the frothing of the colour in the box owing to the agitation to which it is subjected by the revolution of the

furnishing rollers; this is most prominent in colours containing albumen or gelatine, and is remedied by adding a small quantity of olive or some other oil, turpentine, etc. Frothing causes the roller to miss taking up colour in some places, while in others it only gets about half its proper supply, so that the printed piece looks flat and thin. When the colour on the piece tends to come up weak and pale, the defect lies either in want of pressure, to the furnishing roller not taking up the colour properly, or to frothing. Each of these defects can be remedied by appropriate means, obvious to all practical men.

Before printing on, the silk should be well scoured by any of the usual methods described in previous chapters.

Printing on silk is carried out usually in two styles, corresponding to the steam style and the pigment style of the calico printer. In the first style the colour is thickened with a suitable agent, it is then printed on, and the fabric is steamed to develop and fix the colour; in the latter style the colour is used in the form of an insoluble pigment, such as vermilion, prussian blue, ultramarine, and the printing colour is made by mixing this with albumen, which on steaming coagulates and becomes insoluble, and so fixes the colour on the fabric.

Steam Style of Silk Printing.

The principle of this style is to make a solution of the colouring matter; thicken this with some body such as starch, gum tragacanth or dextrin, which will prevent the colour from flowing when it is printed on

the silk, then to submit the printed fabric to the action of steam, whereby the colour is properly developed and fixed on the silk, then after soaping to clear off the thickening, the fabric is ready. This process is applicable to almost all classes of coal tar colours.

Although it is not absolutely necessary, it is best to prepare the silk by mordanting with alumina or tin, especially with azo colours; this can be done by either of the following processes:

1st. Prepare a bath with $4\frac{1}{2}$ lbs. alum, $7\frac{1}{2}$ ozs. soda crystals, and $7\frac{1}{2}$ gallons water; boil until the precipitate which is formed redissolves, then enter the silk, work well for twenty minutes to get the fabric thoroughly saturated, then allow to steep over night, wring and dry.

2nd. Prepare an alum liquor of 8° Tw., work the silk in this for half-an-hour, then allow to steep for one day, wring out and dry.

3rd. Prepare a bath with perchloride of tin at 40° Tw., enter the silk, work well for twenty minutes, steep for two hours, wring, run through a weak bath of soda crystals, rinse and dry.

4th. Prepare a bath with stannate of soda at 6° Tw., run the silk through for half-an-hour, wring out, and pass through sulphuric acid at 1° to $1\frac{1}{2}$° Tw., wash and dry.

By these processes alumina or oxide of tin is deposited on the silk, and these bases combining with the colouring matter, form an insoluble colour lake, and thus fix the colour on to the silk more permanently than if they were absent, at the same time they increase the brilliancy of the colour.

Thickenings for Silk Printing.

Any of the following thickenings may be used for steam colours in silk printing.

For Hand Printing.

1. 5 lbs. of good white starch and 5 lbs. of white dextrine are mixed with 1 gallon of water, $7\frac{1}{2}$ lbs of acetic acid of 12° Tw., 2 lbs of olive oil and $2\frac{1}{2}$ gallons of water are then added, and the whole boiled into a paste. This will suit almost all colours.

2. 5 lbs. of good white starch are mixed with one gallon of water, and $2\frac{1}{2}$ lbs. of pale glue previously dissolved in $2\frac{1}{2}$ gallons of water are added, and the whole boiled up to a paste, after allowing to cool, add 5 lbs. of acetic acid 7° Tw., and 2 lbs of olive oil.

For Roller Printing.

1. 5 lbs. of starch, best quality, are mixed into a paste with $\frac{1}{2}$ a gallon of water, 1 lb. of gum tragacanth previously dissolved in $1\frac{1}{2}$ gallon of water are added, and well mixed, 5 lbs. acetic acid of 12° Tw., 3 lbs. of olive oil, and 2 gallons of water are then stirred in and the whole boiled to a paste.

2. Dextrine thickening is made by boiling for half-an-hour 10 lbs. of dextrine in 1 gallon of water.

3. Make a mucilage by steeping 1 lb. of gum tragacanth in 1 gallon of water for three days, then boil until dissolved; add 20 lbs. of dextrine which has been previously mixed with 4 gallons of water, boil for about fifteen minutes, add 2 lbs. of glycerine and 2 lbs. of acetic acid.

Printing Colours.

To print with the so-called basic, or as they are called by the calico printer, tannic colours, such as Magenta, Brilliant green, Thioflavin T., Auramine, Safranine, Bismark brown, Chrysoidine, Rhodamine, Violets, Cotton blues, prepare a colour with

1 gallon of Thickening 1.
1 oz. of dyestuff dissolved in
2 pints of water, and
1 lb. of acetic acid.

By increasing the proportion of the dyestuff darker shades are obtained, by decreasing, paler shades are produced.

Another plan for producing paler shades is to make a standard printing colour as above, and then to reduce by adding thickening. No. 2 Dextrine thickening is the best for this purpose, or a gum thickening may be used.

For azo colours, such as Croceines, Scarlets, Oranges, Napthol yellows, Tartrazine, Fast red, Fast blue, Azo green, etc. Make the printing colour with :

½ gallon of thickening 2.
1 oz. colouring matter previously dissolved in
¼ pint of water,
1 oz. sodium phosphate,
½ oz. tartaric acid,
make up to 1 gallon with water.

Reduced down for 2 shades with thickening 2 or 3.

After printing, steam in a steaming chest for $\frac{1}{2}$ to 1 hour at about 10 lbs. pressure. Then wash and dry.

In all cases before using the printing colours should be strained through a sieve, to separate out any grit or lumpy matter.

As the printing colour is made in the same way for all the coal tar colours comprised in the two classes named above, it is not deemed necessary to give more specific directions for producing shades with the simple colours; of course the colours can be combined in a variety of ways to produce compound shades, and a few recipes for such will be given in the Appendix.

To print Alizarine colours on silk for the purpose of obtaining fast shades and tints, the following process may be adopted.

The particular colour is mixed with the requisite mordant, sulphate of alumina, copperas, or acetate or chloride of chromium to fix it, sufficient thickening, and if there is any tendency for too much acidity, then some sodium acetate. In the case of using sulphate of alumina and copperas then some oxalic acid must be added, which acts by causing a reduction and partial solution of the colour lake in the printing colour. For the thickening any good starch-tragacanth thickening will answer; a good one can be made with

2 lbs. gum tragacanth

soaked in

1 gallon of water,

when well soaked

3 gallons of water are added,
10 lbs. of starch
are stirred in and the whole boiled well, then
5 gallons of water
are added, and the mass again boiled for one hour, when cold it is ready for use.

After the printing, the pieces are dried, then steamed for two hours at a pressure of $7\frac{1}{2}$ to 10 lbs., after which they are soaped at 133° F. in a soap-bath containing 46 ozs. soap in 10 gallons of water, this is repeated once or twice, then the pieces are washed and dried.

When care has been taken in carrying out the details of the process the results are good, the tints obtainable are brilliant and quite fast to light, air and washing.

As Alizarine colours may be classed, Alizarine, Alizarine orange, Alizarine blue, Alizarine Cyanine R and G, Alizarine Bordeaux B and G, Anthracene brown, Alizarine yellows, Anthracene yellow, Gambine yellow, Gallein, Gallocyanine, Anthracene Green, Cæruleine, and a few others.

Printing Silk with Dyewood and other Colouring Matters.

In this section the application to silk printing of other colours than those derived from coal tar will be described. These bodies are far more difficult to use, and the results not so certain as the coal tar colours, and they are therefore being gradually displaced, though not so rapidly as might be desired in the interest of silk printing; the use of coal tar colours

being easier and much cheaper would (because of the greater brilliancy and lower cost of the printed fabric) lead to a greater demand for these goods.

The colours under consideration are applied by the steam style, or the pigment style; the latter is, however, not much used, owing to the want of lustre in the colour of the printed goods.

The silk is usually prepared with tin, as has already been described, although such preparation is not essential, and for fine designs on white grounds is often omitted.

The wood colours, logwood, bark, berry, fustic, cochineal, etc., require a mordant to fix them properly; this mordant is always mixed with the printing colour, chiefly in the form of a salt of a volatile acid, *e.g.*, acetate of alumina, acetate of chrome, etc. On steaming the volatile acid goes off, and the base combines with the colouring principle of the dyestuff, and causes the development and fixation of the colour on the fabric.

The following recipes will serve to show how the colours in question are applied.

Standard Green.

Bark liquor at 30° Tw. . .	5 pints.
Sulphate of alumina . .	14 ozs.

When all the alumina is dissolved, which is facilitated by heating to 120° F., there is added

Gum water, 1 in 1 . . .	2 quarts.

Cool and add

Prussiate of indigo . . .	$3\frac{1}{2}$ quarts.

Prussiate of indigo is prepared by taking $3\frac{1}{2}$ quarts of acid extract of indigo, and stirring in $5\frac{1}{2}$ lbs. yellow prussiate of potash until dissolved. The mixture, after clarifying, is ready for use.

Print, steam and wash. This gives a green of a good tone.

Green Standard A.

Acetate of alumina 10° Tw. .	6 quarts.
Persian berry liquor 14° Tw. .	6 „
Gum liquor 1 in $2\frac{1}{2}$ . .	6 „
Heat to about 170° F., then stir in	
Powdered yellow prussiate of potash	14 lbs.
Allow to cool, then add	
Oxalic acid	12 ozs.
Tartaric acid	3 lbs.
Tin pulp	4 lbs.

Tin pulp is prepared by dissolving 3 lbs. of yellow prussiate in 8 quarts of hot water: also dissolving 3 lb. tin crystals in 8 quarts of cold water, mix the two solutions; allow to settle, pour off clear liquor, add fresh water, stir well, allow to settle, pour off clear top liquor, throw precipitate on to a filter, and allow to drain, keep in well closed bottles for use.

Print, steam, and wash.

Dark Green.

Green standard . . .	$10\frac{1}{2}$ quarts.
Green standard A . . .	3 quarts.
Prussiate of indigo . . .	$1\frac{1}{2}$ „

Yellow Green.

Green standard A . . .	3 quarts.
Berry liquor, 14° Tw. . .	1 „
Acetate of alumina 10° Tw. .	1 „
Gum liquor 1 in 2½. . .	1 „

Print, steam, wash and dry.

Black.

Water	21 quarts.
Logwood liquor 30° Tw. .	22 pints.
Starch	7 lbs.
Dextrine	20 lbs.

Boil up, add

Blue stone	2½ lbs.
Copperas	2½ lbs.

Stir well, when cool add

Extract of indigo . . .	3 lbs.
Prussiate of indigo . . .	9½ ozs.
Nitrate of iron . . .	9 lbs.
Oil of turpentine . . .	9½ ozs.

Black.

Gall extract 22° Tw. . .	9 lbs.
Starch	1½ lb.
Dextrine	1½ lb.
Olive oil	3 ozs.

Boil well, cool and add

Black iron liquor 20° Tw. .	20 ozs.
Nitrate of iron 72° Tw. . .	12 ozs.

Dark Prussiate Blue.

Boil up

Starch	2 lbs.
Water	6 quarts.
Tartaric acid	5 lbs.
Oxalic acid	4 ozs.

Cool, stir in

Powdered yellow prussiate .	5 lbs.
Tin pulp.	$6\frac{1}{2}$ lbs.

If not thick enough add sufficient dextrine. Print and steam.

Bright Prussiate Blue.

Water	5 pints.
Starch	$1\frac{1}{4}$ lb.
Gum tragacanth liquor 1 in 10	1 pint.

Boil up, stir in

Red Prussiate	18 ozs.
Yellow Prussiate. . . .	$2\frac{1}{2}$ lbs.
Tin pulp	$5\frac{1}{2}$ lbs.

Allow to cool and add

Tartaric acid		$3\frac{1}{4}$ lbs.
Oxalic acid . .	4 oz.	dissolved in $\frac{1}{2}$ pint water.
Sulphuric acid .	$3\frac{1}{4}$ ozs.	diluted with water, $3\frac{1}{4}$ ozs.

Print, steam, wash, and dry.

This gives a fine blue: for pale blues the above colour can be reduced by mixing in any proportion with the following reducing paste:

Blue Reducing Paste.

Starch	6 lbs.
Water	6 gallons.
Boil, allow to cool, then stir in	
Oxalic acid	$2\frac{1}{2}$ lbs.
Tin pulp	8 lbs.
Perchloride of tin	2 lbs.

Indigo Extract Blue.

Water	$2\frac{1}{2}$ pints.
Alum	3 ozs.
Tartaric acid	4 ozs.
Indigo extract.	8 ozs.
Gum in sufficient quantity.	

Yellow Standard.

Dissolve together	
Alum	2 lbs.
Tartaric acid	12 ozs.
Water	7 quarts.
Stir in	
Berry liquor at 14° Tw. . . .	10 quarts.
Gum water 1 in $2\frac{1}{2}$	5 quarts.

Cochineal Red Standard.

Cochineal liquor at 8° Tw. .	5 quarts.
Gum	$4\frac{3}{4}$ lbs.
Tin crystals	$\frac{1}{2}$ lb.
Oxalic acid	$\frac{1}{4}$ lb.
When dissolved add	
Perchloride of tin	$\frac{1}{4}$ lb.

Orange Standard.

Annotto	3 lbs.
Water	3 quarts.
Potash	1 lb.

Boil, allow to cool, add

Starch	½ lb.
Gum	1 lb.

Boil till thick.

Brown Standard.

Peachwood liquor	26° Tw.	.	2 quarts.
Logwood „	30° „	.	1½ „
Bark „	30° „	.	1½ „
Acetate of alumina	18° „	.	3 „
Water		.	1 „
Verdigris . .	2½ lbs.	}	Dissolved together in 1 quart of water.
Cream of tartar .	1 lb.		
Gum water 1 in 2½ . . .		.	14 quarts.

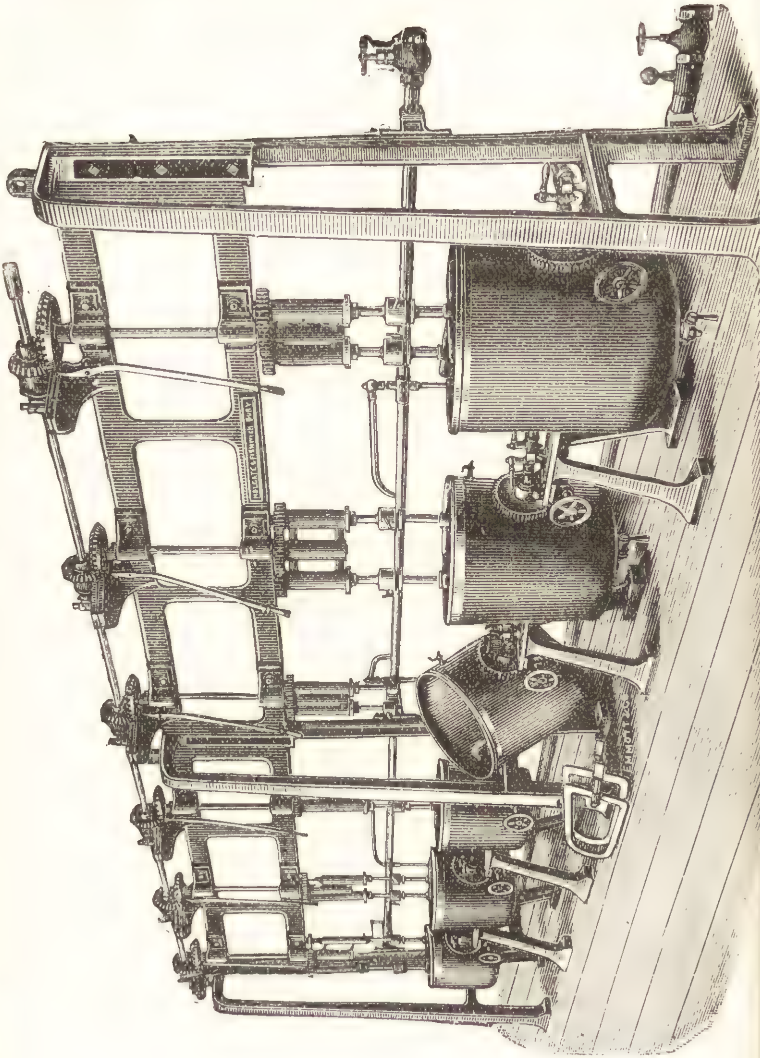
In all cases the colour is printed, the goods hung for a few hours, then steamed, washed, and dried.

By reducing any of these standards with a reducing liquor made of gum and starch of the right consistency for printing, a great variety of light shades can be got. By mixing them in various proportions compound shades can be obtained, several recipes for which will be found in the Appendix.

Colour Mixing.—One of the great secrets of success in printing on silk, or indeed on any other fibre, is to properly prepare the colours, as they are called, for the actual printing; these must be uniform and homo-

geneous in composition, fine and free from grit; if they are not, good results cannot be obtained. To insure this result the materials constituting the colour must be thoroughly mixed together; this is generally done by boiling in pans. These colour-pans are usually made of copper, but other materials may be used, such as block tin. Enamelled iron pans are excellent for the purpose; these may be heated by fire, but steam heating is by far the best, and in most colour shops there is a range of jacketed copper pans fitted, which can be heated by steam or cooled by water when required, Fig. 14, which shows a range of rather large sized pans. If the pans are large they are fitted with mechanical agitators; if small the stirring may be done by hand. Generally the pans are made to tilt, so that the contents can be readily transferred to other vessels.

In mixing the starch and gum should first be prepared by adding to them sufficient cold water to form a uniform smooth paste; they are then thinned with water and boiled up, the colouring matters added, then any acid or oily matters, finally the mordants; after which the colours are strained through thin calico, or in a straining machine, for use. A good rule is simply to mix the colours as required, because some colours do not keep, and none improve by keeping. With simple colour which will keep it is usual to prepare extra deep colours called "standards," from which the actual printing colour is made by reducing with thickening; often, however, these standards, although convenient, are wrongly used, and lead to a waste of material; for instance, a standard


HOLGATE & FISHWICK BURY

colour is made of colouring matter, mordant, and thickening. Often in reducing it, it is mixed with more thickening and mordant, which is unnecessary and wasteful, because all the mordant the colouring matter requires will have been added in the first instance, and any additional quantity is wasted and often injurious. With the exercise of a little judgment the use of standards is admissible; probably the best plan would be to keep the thickening ready mixed, as also standard mordants and standard solutions of the colouring matters. These could be made in large quantities and mixed together in any required proportions when wanted, always adjusting the proportion of mordant to suit the quantity of colouring matter used, and that of the thickener to suit the shade that it is desired to obtain. The addition of what may be called correctors, such as olive oil, turps, oxalate of potash, phosphate of soda, the object of which is to correct certain defects of the printing colour, such as frothing, acting on metals, etc., must be made in proportion to the total quantity of printing colours, and can be added last of all.

One reason why roller printing is not adopted to any great extent in silk printing, is the great liability of defects, streaks, stains, etc., to be extended by that process over a great surface of material, which involves considerable loss. In block printing any defect is confined to the one impression, and may not be noticed.

CHAPTER VII.

SILK DYEING AND FINISHING MACHINERY.

THE plant used in a silk dyeing and finishing works is comparatively simple, although of recent years it has tended to become more complicated, owing to the demand for quick work and the adoption of the system of dyeing silk fabrics in the piece.

Yarn Dyeing.

Hand Dyeing.—Small quantities up to about 2 lbs. can be dyed in earthenware vessels, especially if the silk does not require to be heated more than 150° to 160° F. Larger quantities are best dyed in a rectangular wooden dye-vat, Fig. 15, measuring about 5 feet long by 24 inches deep, and 22 inches wide; this will take easily about 50 lbs. of silk yarn, which is placed on hickory wood sticks and hung in the vat as shown in the drawing. The hanks are turned over from time to time by two workmen, one on each side of the vat. A steam-pipe passing to the bottom of the vat serves for heating the liquor it contains up to any required degree. A plug at one end near the bottom serves to discharge the vat of the exhausted

liquor after the dyeing is completed. The same vat may be also used for mordanting operations.

Mechanical Dyeing.—Although as yet most of the dyeing of silk yarns is done by hand, probably because the expensive nature of the material makes it desirable not to run any risk of loss by damage from machinery, yet it is possible to apply almost any one

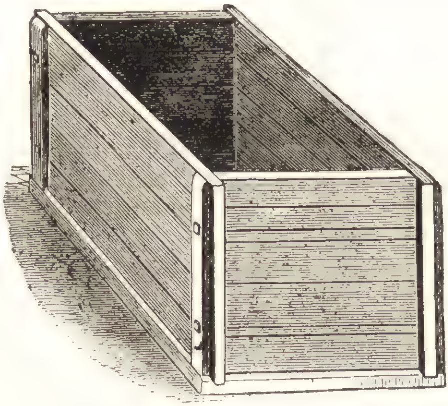


Fig. 15.

of the forms of yarn-dyeing machines used for cotton, and in a few of the largest silk-dyeing works such machines are to be found. It is scarcely possible in this work within the space at disposal to notice all the machines which might be used, but a brief notice of the best known may be useful.

Reel Machines.—Under this head several makers put on the market forms of dyeing and washing-machines the principle of which is that a revolving

reel or bobbin is placed over a trough containing the dyeing or washing liquor; on this reel the hanks of yarn are hung, one end of the reel is connected with the driving mechanism of the machine, whereby it is caused to revolve; the other end is free, so that no impediment is offered to the free putting on and taking off the hanks of yarn. There are usually a number of these reels placed side by side over a long rectangular trough when large quantities of material are being dyed, or if small quantities only are to be dyed each reel is suspended over a separate dye vessel, so that a workman can dye with such a machine several lots at once. Fig. 16 is a drawing of such a reel yarn dyeing machine, made by Mr. James Robertshaw of Manchester, seen from the back, and showing the mechanism by which the reels are lifted up and down, and the hanks of yarn in and out of the dye liquor. To this machine a wringing arrangement is added. This machine is serviceable for dyeing large lots; for small lots the form mentioned above may be used. In some makes these reels are fixed in one position, while in others arrangements are made whereby the reels can be raised out of or lowered into the dye-liquor as may be required; this form possesses some advantages over the other form, and more even dyeing of a batch of yarn can be secured.

Pole Yarn Dyeing Machines.—In this form the yarn is hung on one pole or between two poles, and is carried by the action of the machine through the dye liquor. There are many varieties of these machines. Corron's is a good form, in this the hanks are hung on

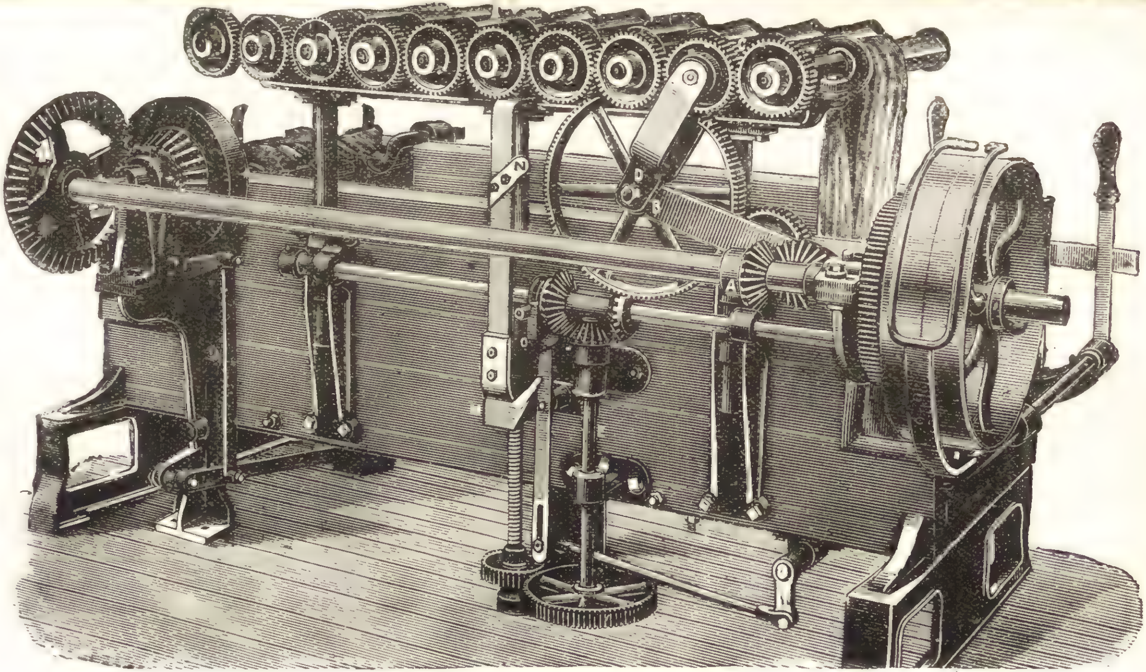


Fig. 16. Yarn Dyeing Machine.

carriers in the dye liquor, and the machine carries them from one end of the machine to the other, turning the yarn over at the same time. Klauder's machine is a recent make, and works well for cotton ; as yet it has not been used for silk dyeing, but it would answer well in this trade. In this machine the hanks are placed taut between two poles, radially between two revolving discs, that carry during their revolution the silk yarn through the dye liquor, contained in a semi-circular trough, at the same time once during every revolution of the discs, the rods carrying the yarn are caused to revolve, to insure that every portion of the yarn is dyed.

Wringing Machines.—After dyeing, mordant, and washing, the hanks of yarn require wringing ; this can be done by hand in the manner well known to all dyers, but it is more effectually done by machines. One form of wringing-machines resembles the household roller mangle, the silk passes between two rollers constructed either of wood or india-rubber, by means of screws or weighted levers some pressure can be brought to bear on the rollers, by which means the surplus moisture is wrung out of the silk ; to prevent damage to the fabric or fibre when using wood rollers, it is best to lap one or both with flannel ; in some makes an endless belt passing round the bottom roller serves to carry the silk between the rollers, but there is very little advantage in this addition to the machine.

Another form of wringing-machine, shown in Fig. 16 in connection with a dyeing machine, works in imitation of hand-wringing, two strong hooks, one fixed, the other made to revolve, are placed over a

trough; the hanks of yarn are hung on these, the machine is set in motion, and the moisture is wrung out. Usually these machines are so constructed as to give a certain number of revolutions of the movable hook, then to reverse the motion, this being regulated by the degree of dryness required and size of hanks; this is done so that no undue tension shall be put upon the fibres. This form is applicable only to hanks, while the roller wringer can be used either for hanks or for piece goods.

The use of wringers leads to some saving in materials, and to more uniform results in scouring or dyeing operations.

Hydro-Extractors.—Another machine which can be used for extracting the surplus liquor from wet silk, and which is eminently suitable for partial drying of the silk after the washing operations, is the hydro-extractor, Fig. 17. This machine is made in a variety of forms by different makers, but the principle on which they work is the same in all. A metallic vessel of a cylindrical shape, with perforated sides, is made to revolve at a high speed, some 1,500 to 2,000 revolutions per minute; this is commonly known as the basket, the goods are packed in this close against the sides; during the revolution of the machine the liquor they hold is by centrifugal action thrown outwards through the perforated sides of the basket; an outer casing serves to support the basket, and to convey the escaping liquor to an outlet, whence it runs out of the hydro-extractor. The machine is generally known among the workmen as the "whizz," and the operation as "whizzing." It is very effectual, and the goods are

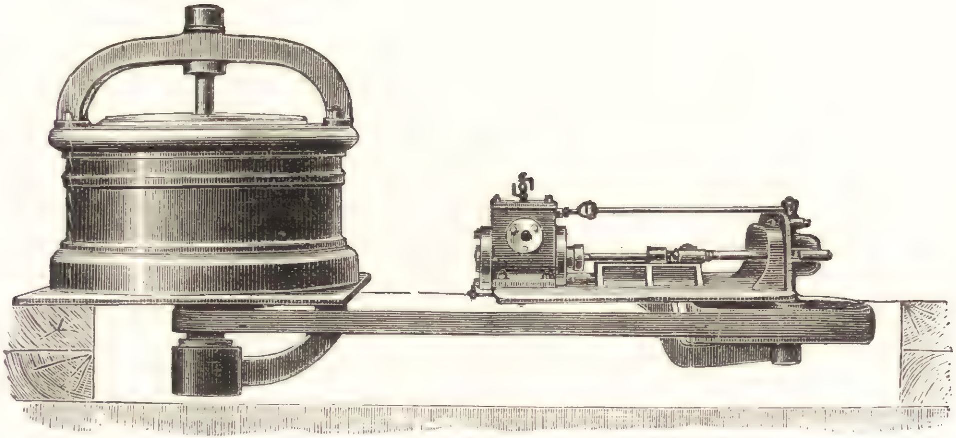


Fig. 17. Hydro-Extractor.

taken out nearly dry ; ten minutes in the whizz will do as much as five hours drying in the stove.

Hydro-extractors are made of various sizes, and silk bleachers and dyers will have no difficulty in getting one that will just suit them. The driving mechanism may be arranged in various ways, either under or over the machine ; under-driven hydros, such as that shown in Fig. 17, are the best, as the driving gear is not in the way of the workman while he is taking out or putting in the goods. Then again, the driving may be from the main driving-shaft of the works, or by means of a separate donkey engine, and this latter may be geared direct or through separate gearing; the latter plan is by far the best. As the hydros have to be driven at a high speed, and main driving shafts as a rule work at low speeds, to drive hydros from such shafts necessitates gearing to bring the speed up ; this extra gearing takes force to drive it, and is likely to be costly for repairs, on account of the great strain to which it is subjected. To drive by a donkey engine geared direct means great wear and tear on the working parts of the engine due to the high speed. A separate engine working at a moderate speed, and transmitting the power to the hydro by belting is much better.

Piece Dyeing Machines.—Pieces may be dyed in two ways : 1st, they may simply be put loose in the dye-bath, being if required simply drawn out from time to time by winces, and then re-entered into the bath ; the defect of this method is that the goods are liable to come out unevenly dyed, this defect being much more prominent with pale tints than with blacks or deep tints ; 2nd, the pieces may be passed

repeatedly through the dye-bath in an open form ; this method necessitates the use of some kind of machine, the simplest form of which consists of a vat to hold the liquor, such vat having sloping slides (see Fig. 18) ; so as to economize liquor, a roller is fitted near the bottom of the vat, while on the top are two rollers, one on each side ; the piece is wound on one of these, the end passed round the bottom roller, and fastened to the second top roller ; the vat is now filled with the liquor, the piece wound from the first to the second, and when fully wound the direction of the winding is reversed ; this alternation carrying the piece through the dye liquor is repeated as long as is necessary to dye the goods. Such a machine is commonly known as a "dye jig," and it requires constant attendance to wind and re-wind from one roller to the other ; to avoid this automatic jigs have been invented, in which the change of direction of revolution is effected by the driving motion of the jig itself. These jigs are as a rule very efficient machines, and with their help very level colours can be obtained.

Piece Silk Finishing Machinery.—This is by no means complicated, at most it comprises three machines, a stiffening mangle, drying cylinders, and a calender.

The Stiffening Mangle consists of a trough to contain the stiffening composition ; in this revolves a wooden bowl, above this and pressing on this bowl is a second, and sometimes, but not often, there is a a third bowl above this, all made of sycamore ; the silk passes through the stiffening mixture under the bottom bowl, during which it becomes impregnated

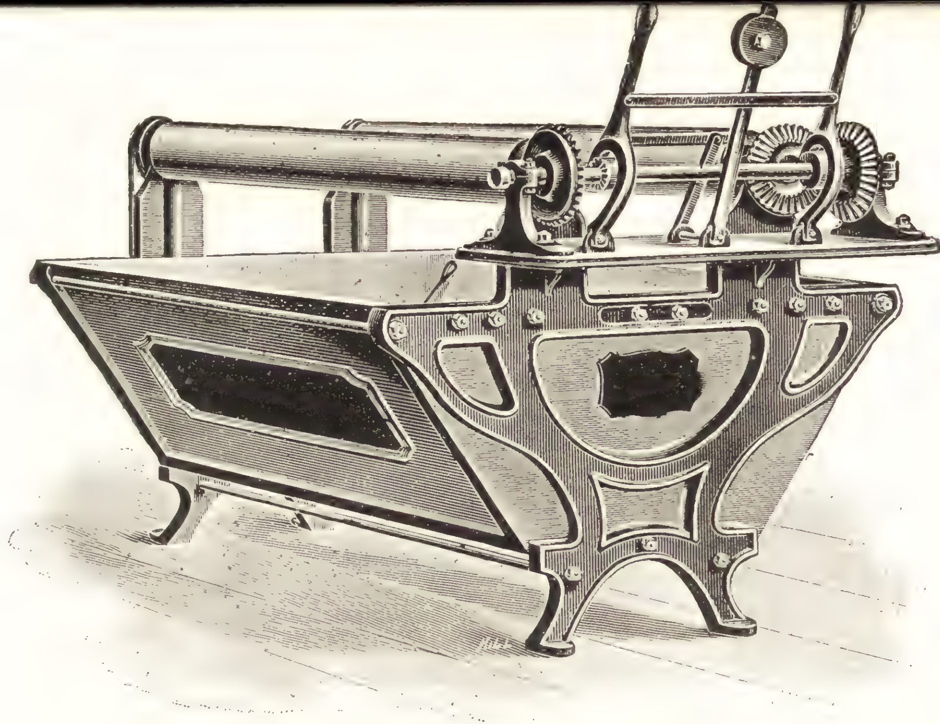


Fig. 18. Silk Piece Dyeing Machine. Maker, R. Middleton, Leeds.

with the composition used to stiffen it, then it passes between the 1st and 2nd, and the 2nd and 3rd, which press out all the surplus liquor, after which it passes to the drying cylinders.

Drying Cylinders.—These consist of a range of hollow tin cylinders, Fig. 19, made to revolve by suitable gearing, and are heated by steam; over these the stiffened silk passes, and is dried. As a rule the cylinders are arranged in two rows, one above the other, the centres in two horizontal lines, but the centre of the first top cylinder comes between the first two bottom cylinders, and so on, in this way economizing room; the silk passes under the bottom row of cylinders and over the top row, and is dried on both sides. The engraving shows the cylinders as used in the finishing of cotton goods. Those used in silk finishing are of similar construction but not so large in size or so many in number. The drying may be partial or complete, depending upon, (*a*) the speed at which the fabric passes over the cylinder, the quicker the speed the less are they dried, (*b*) the temperature of the cylinders, obviously the higher this is the more thorough will the drying be; the finisher, therefore, by regulating the speed of the cylinders, and the quantity and pressure of the steam he sends into them, can regulate the drying of the fabrics; as a rule they should not be completely dried.

It will be found best to combine the stiffening mangle and drying cylinders into, as it were, one machine, driving them by a single engine. Owing to the necessity of regulating the speed to suit different conditions of the fabric and different finishes, it is not

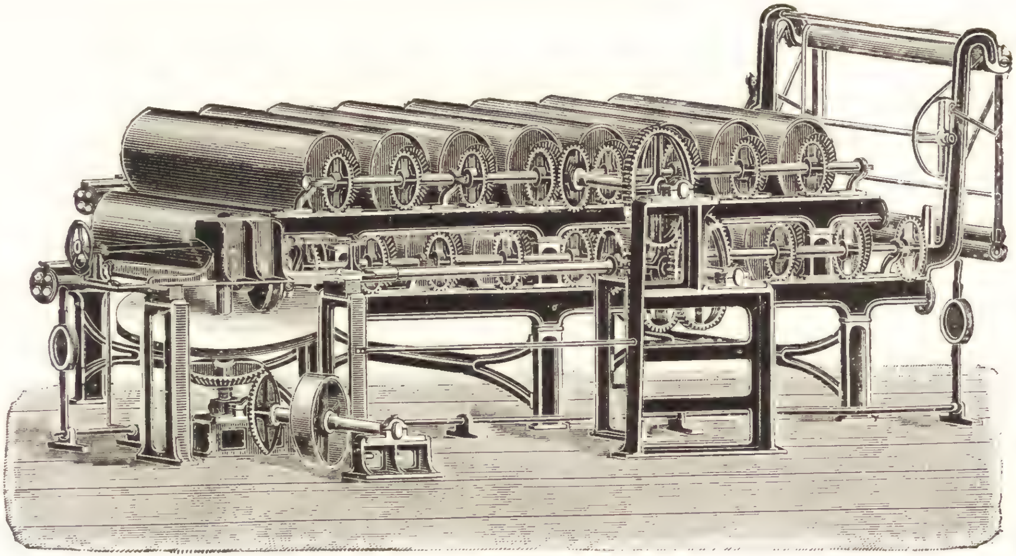


Fig. 19. Piece Drying Range. Makers, J. H. Riley and Co., Bury.

a good plan to drive them from a main shaft connected with other machinery, but to drive by a separate engine.

Into the cylinders the steam passes at one end through one of the journals (which are made hollow) of the cylinders: a good deal of this condenses and forms water, which if allowed to accumulate would be detrimental to the working of the cylinders, by reducing very materially the drying power and increasing power required to drive the cylinders. To prevent this accumulation of water the cylinders are provided with buckets which collect the water as it is formed, and pass it out of the cylinder through the journal at the end opposite to that at which the steam entered.

Instead of a number of small cylinders the silk is passed over one large cylinder heated as before with steam. In this case only one face of the fabric touches the cylinder, while in the other form of drying machine both faces touch the cylinders.

Silk Finishing Calenders.—To impart a gloss to silk fabrics, they are passed through a calender, Fig. 20; this machine is very like a domestic wringing machine in construction, it has two or three bowls or rollers placed in a suitable framing one over the other, the bowls being driven by suitable gearing. When a two-bowl calender is used one is made of highly polished chilled iron, the other of paper; a three-bowl calender would have the middle bowl of chilled iron, the others of paper. The iron bowl is so constructed that it can be heated to increase the gloss or lustre on the finished fabrics. This heating may be done either by means

of red-hot bars placed in the interior of the bowl, which is made hollow, or by passing a current of steam into it, or by heating it with gas; the two latter methods are preferable, being convenient and easy to

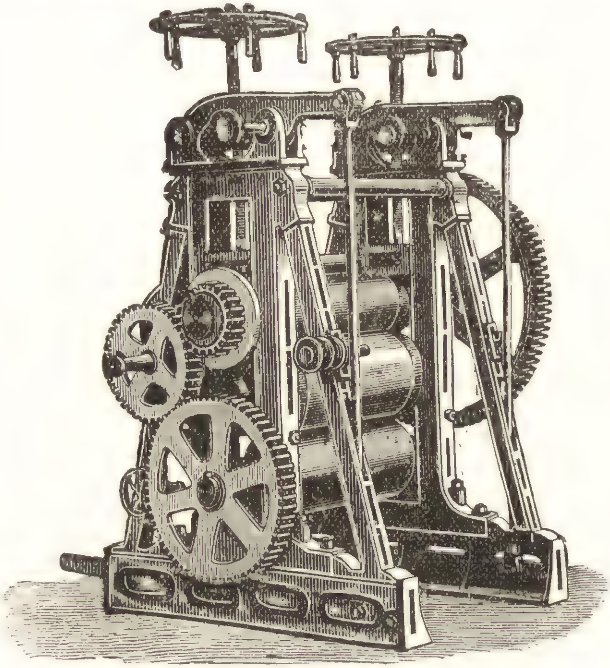


Fig. 20. Finishing Calender.

use. With a two-bowl calender one nip only can be given to the fabrics at one passage through the machine, with a three-bowl calender two nips can be given, or two pieces may be run through at one time,

and they receive one nip, which for silk is usually sufficient. The calender requires to be kept very clean, free from water and grease, dirt and grit getting between the bowls damages them very much, causes streaks and cuts which mark the fabrics passing through. The goods are placed on batching rolls, guided if necessary over scrimping rails to take all creases out, and after running through the calender, are wound on other batching rolls.

Pressure is placed on the bowls partly by their own weight, which is considerable, and partly by means of a system of weighted levers and screws. The weight used in finishing silk is comparatively slight, generally that produced by the weight of the bowls is sufficient.

For further details regarding the construction of mangles, drying cylinders, and calenders, reference may be made to the author's "Finishing of Cotton Fabrics," where these machines are fully described and illustrated.

Although, as a rule, the above are the only machines used in silk finishing, yet for certain classes of goods, satins, half-silk fabrics, etc., these are subjected, after calendering, to pressure in a hydraulic press, highly glazed cards being placed between the folds of the fabrics; this process increases the lustre of the goods very much. Occasionally the hydraulic pressures are fitted with a number of hollow plates which can be heated by steam, this heating also tending to increase the lustre of the fabrics which are pressed. It is not necessary to describe in detail the construction of a hydraulic press, as this is fairly well known to most persons.

After calendering and pressing, the fabrics are made up for sale; this is done in a variety of ways to suit different markets, and scarcely requires detailed notice here; besides, fashions in making up alter, and a description which might be correct to-day would not be so a year hence.

Silk Finishing.—As silk possesses naturally a beautiful lustre it requires the aid of few materials to impart lustre to it; generally pure silks are only subjected to a gentle calendering; half-silks are further treated, they are first stiffened with a composition of various bodies, this composition must be perfectly clear and transparent, otherwise it might injure the brightness of pale tinted fabrics. The substances mostly used are gum tragacanth, pale glue or gelatine, paraffine wax, white wax and, soap. The latter is rarely applied, and only when paraffine or white wax forms a constituent of the composition. Gum tragacanth and glue are used in the form of watery solutions, the materials are first soaked in water, then boiled up to a perfectly homogeneous mass, containing 1 lb. glue and 2 lbs. gum tragacanth in 10 gallons. This will be found sufficient for all ordinary purposes. With those fabrics containing a large proportion of cotton, on which some lustre is to be obtained by finishing, a good composition can be made from

$3\frac{1}{2}$ lbs. paraffine wax,
1 lb. white wax,
$2\frac{1}{2}$ lbs. castor oil,
2 lbs. soap,
$4\frac{1}{2}$ gallons water,
$\frac{1}{2}$ lb. glue.

The goods may be finished either on one or on both sides. For single finish the fabric is stiffened in the composition, dried over the tins, then run once through a light calender. If they are steamed for a minute or two afterwards it adds to the lustre of the finish. For a finish on both sides, the fabric is stiffened on the mangle, then dried on the tins, passed twice through the calender, once with back up, once with face up; steaming may follow, if it is desired to give a more thready appearance to the fabric.

Silk Yarn Finishing.—To impart the fullest lustre to silken yarn it is, after bleaching and dyeing, submitted to a series of mechanical operations.

Shaking out.—The first is known as shaking out (Fr. *sécouage*), which is best done before the silk has become dry, which operation it facilitates by making the silk more open, and thus exposing a larger surface to the action of the atmosphere. The object is to straighten out the yarn, and to remove any creases or kinks from it. It can be done either by hand or machine. In the former case the yarn is thrown over a peg projecting from a strong post or a wall, the former is preferable as it is in a better position for the workman to manipulate the yarn; this peg must be made of hard wood, and be as smooth and as polished as possible; these last two features help to add lustre to the silk: over this peg the hanks are hung, the workman then inserts a smooth pole into the bottom loop, and vigorously and quickly shakes the yarn, from time to time he alters the position of the hank on the peg, the shaking is continued as long as is required to straighten the silk, which experience will

show. A very good machine for shaking out is made by M. Cæsar Corron, of St. Etienne. In this machine the hanks are hung between two reels, the upper reel is made to revolve, while the bottom reel is, by a press plate, subjected to a continuous pressure which effectually stretches out the yarn, the machine works very simply and regularly. It may be mentioned that the parts here enumerated are quadrupled, so that four lots of yarn can be manipulated at once. Another form of machine consists, essentially, of a hollow well-polished metal box of a rounded triangular shape is fixed firmly in the frame-work of the machine; below this is placed a revolving reel, the hanks of yarn are hung between these two parts, the reel set in motion which carries the yarn round over the box, at the same time, by suitable mechanism, the reel is caused to descend, thus stretching the yarn, the drawing over the edge of the metal box takes out the kinks well and at the same time imparts some lustre to the yarn; this can be increased by heating the box by means of a steam jet arrangement provided for that purpose. The parts herein noted are duplicated. The machine works well. There are several makers of these machines.

Stringing and Glossing. (Fr. *chevillage.*) — After the hanks, shaken out by hand, had been straightened, it was usual to twist them up as tightly as possible, an operation known as stringing, which adds to the lustre of the silk yarn. The stringing up is repeated several times, always taking care that the loops of the hank are hung in different positions on the stringing-up peg each time. In the case of sewing silks it is customary to string up the hank, then fasten it in this

position, and leave it for four or five hours; at the end of this time the stringing-up is repeated, and this is done many times during a period of from ten to fifteen days, with the object of adding to the gloss of the yarn.

Souple silks are always strung up with the object of more fully separating the two silk fibres one from another, and adding lustre. With these silks it forms the final operation.

Stringing is now mostly done by machine; this machine is constructed as follows:—a revolving reel is provided on which the hanks of silk are hung, below this is placed another reel on an elbow-shaped piece, on which it is loose; this reel has two motions, it can revolve and thus cause the yarn to twist, at the same time it can rise and fall to suit the shortening and lengthening of the hanks as they twist and untwist. The action of the machine is somewhat as follows:—the lower reels are made to revolve, thus twisting up the hanks when they are tight, the machine automatically reverses the motion and the hanks untwist, at the moment when they are completely untwisted, the upper reels revolve, thus turning the hank round and forming new centres for the next twisting. These movements are repeated several times until the operation is finished.

Lustreing.—Silk yarns are lustred by causing them to be exposed to the action of steam in an oven at the same time that they are stretched between two highly polished revolving steel rollers. The hanks are hung on the rollers, the oven closed, and steam at about 5 to 10 lbs. pressure admitted, the rollers are caused to

revolve, and at the same time are gently drawn apart; they thus stretch and open the silk yarn. In such a machine the silk acquires a high degree of lustre. These lustreing machines are made of several sizes, sometimes with two ovens, so that the same mechanism can actuate two sets of rollers; in some the rollers are placed horizontally, in others vertically. In one form of these lustreing machines the oven is done away with, and the rollers are made hollow, and can be heated with steam; though good, this scarcely gives a lustre equal to the oven form of machine.

The length of time the silk remains in the oven varies very much with different kinds of silk yarns; soft twisted yarns require less time than hard twisted yarns; from about half-an-hour to one hour is usually sufficient. Both dyed and undyed yarns may be thus treated.

CHAPTER VIII.

EXAMINATION AND ASSAYING OF RAW AND DYED SILKS.

TESTING of Raw Silk.—The value of a sample of raw silk, whether cultivated or wild, depends upon the quantity of actual fibre it contains, and upon the lustre, length and strength of the bave; the latter qualities are not dealt with here, as they chiefly concern the silk manufacturer; the former point is of interest to both silk dyers and silk manufacturers. The amount of actual fibre in silk is found by ascertaining the quantity of water it contains and the amount of gum which it loses on boiling with soap.

The water in silk is a most important feature not only in raw but in spun silks, and when the costly character of the material is taken into consideration, it is somewhat surprising that buyers of silk should neglect it so much. Silk absorbs water very rapidly, to the amount of 25 to 30 per cent. (see page 12) without showing it. Normally it contains from 11 to 13 per cent., the amount varying with the atmospheric conditions under which it is placed at the time. Silk is generally bought on the basis of its containing 11 per cent. of its weight of water; a better basis on

which to buy it would be the amount of actual fibre it contained, because silks can be fraudulently weighted up with other ingredients, and a simple test for water would not show the true value of such silks.

The amount of water in silk is easily ascertained, a skein of the silk is taken and weighed, the sample is now placed in a hot air oven heated from 105° to 110° C. for four hours, it is then taken out and weighed; it is again replaced in the oven for an hour and reweighed, if there is any further loss of weight, it is replaced in the oven for another hour, and so on until the weight remains constant. The weighings must be done quickly as the dried silk absorbs water rather freely.

In the conditioning houses on the Continent, an elaborate apparatus, shown in Fig. 21, is used. The apparatus consists of two concentric cylindrical vessels *C D*, the inner one, *D*, holding the hanks of silk to be conditioned, *A* is a flue conveying hot air at 110° C., this passes first into a space *B*, into which open a number of tubes *t*, that which pass up through the space between the two cylinders *C D* into the top of the inner one *D*, down which they pass, and in doing so dry the hanks of silk; the hot air passes from *D* into flues *E E*, and out through an exit flue *F*. *V* is a valve for regulating the current of air, *M* is a damper to cut off the inner chamber from the flues *E E F*; *T* is a thermometer for registering the temperature. Arrangements are so made that the weighings of the dried silk can be done in the apparatus itself; the operation takes about an hour and a half to two hours.

From the loss in weight the percentage of water is

calculated; it is usual to add 11 per cent. to the percentage of dried silk found, and any difference between the total and 100 is taken as excess of water. The result, however, is not the amount of water originally in the bale at the time of making up. A bale of silk

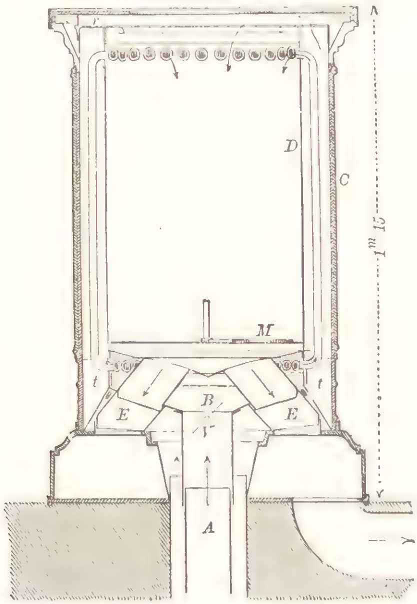


Fig. 21.

imported from, say, China, which at the time weighed 56 lbs., and is invoiced at that weight, may or may not weigh so much. Supposing that when it reached London it weighed 52 lbs., and on conditioning was found to contain 11 per cent. of water; at first it would be supposed that this silk was correct, but such

is not the case, it lost 4 lbs. weight on its journey, of water, so that originally it contained more water than 11 per cent.; this is to be taken into account which is done as follows :—

Original per cent. of fibre in silk =

$$\frac{\text{Sampling weight} \times 100 - \text{per cent. of water found}}{\text{Invoice weight}}$$

deducting this from 100 gives us the percentage of water in the bale as exported.

Thus in the case given we have

$$\frac{52 \times 100 - 11}{56} = 82{\cdot}64 \text{ fibre in silk,}$$

$100 - 82{\cdot}64 = 17{\cdot}36$ per cent. of water in the bale, $6{\cdot}36$ per cent. in excess of quantity allowable.

Again, taking the opposite case, the bale has increased in weight from 56, the invoice weight, to 59, the sampling weight; on testing the silk shows 14 per cent. of water; the true percentage is got as before

$$\frac{59 \times 100 - 14}{56} = 90{\cdot}6 \text{ per cent. of fibre}$$

$100 - 90{\cdot}6 = 9{\cdot}4$ per cent. of water in the bale as exported, actually below the allowed limit.

These examples will show how to allow for any difference more or less in the invoice weight of the bales of silk at the time of sampling for conditioning, always presuming that the bales have not been tampered with in any manner except by adding water.

The actual amount of fibre or the amount of gum in the silk may be estimated as follows :—after having determined the amount of water in the silk, steep the

dried silk in water for an hour, then make a soap bath containing 10 per cent. of the weight of the silk of good pure white soap, boil in this, turning frequently for one hour, then rinse well with clean water, enter into a fresh soap bath, and boil for another hour, repeating these operations twice; then wash the silk well in clear water, dry the silk at 110° C, until the weight is constant, the loss of weight from the original weight of the sample shows the amount of gum plus the water, deducting the latter, the amount of gum and therefore the amount of actual fibre can be calculated. Raw silks lose about 25 per cent., schappe silks about 8 per cent., souple silks from 15 to 20 per cent. Silk may be adulterated by glue, gum, etc., which naturally increase the loss on boiling off.

Testing of Dyed Silks.

Black Silks.—In the case of black silks it is sometimes necessary to know the amount of weighting the silk has undergone, or not only this but the materials which have been used in dyeing and finishing the silk. If it be simply desired to know the amount of weighting, then the sample of dyed silk is dried in the air oven at 100° to 110° C., weighed and treated by boiling in various reagents, binoxalate of potash will in general remove nearly all weighting materials from the silk, or it may be alternately boiled in weak carbonate of soda, hydrochloric acid and oxalic acid baths, which will leave the silk of a faint brownish colour; if a prussian blue bottom has been given this may resist the treatment, then a weak caustic soda bath, followed by a washing,

then an hydrochloric acid bath and a final washing will remove this; care is taken not to use too strong baths for fear of tendering or dissolving the silk. In any case after washing, the silk is dried at 100° to 110° C. and weighed, the loss in weight gives the percentage of weighting and dyeing materials in the silk.

It is usual to estimate the amount of weighting as the increase in weight of the raw silk; this fact makes it extremely difficult to get accurate figures, because the process of extraction leaves the fibre in practically an ungummed state, and there are no means of ascertaining how much gum and water the silk contained originally; under these circumstances, perhaps the best thing to do is to add 36 to every 64 parts of dried silk found in the test, thus, supposing a sample of black silk weighed 28 grams before testing and 8·75 grams afterwards, after making the above allowance we find this to be equal to 13·63 grams raw silk, it is evident that the weighting has been about 200 per cent.

To ascertain the nature of the materials used in dyeing and finishing black silks requires a somewhat extended process which consists in:

1st. Estimation of water.
2nd. Boiling with water.
3rd. Treatment with petroleum ether.
4th. Treatment with dilute hydrochloric acid.
5th. Treatment with dilute alkaline leys.
6th. The ash and its examination.

1st. The water is not of a very great amount of importance, and, as a rule, from 10 to 15 per cent.

may be found present; this may be considered the normal amount in silks, and any excess is not desirable, as it might lead to defects, mildew, etc., it may arise from the presence of hygroscopic bodies, such as glycerine, chloride of zinc, or the silk may have been kept in a damp place. The method of estimation of water has already been described.

2nd. *Boiling with Water.*—This is done by boiling the silk for half-an-hour in distilled water, then evaporating down to dryness on a water or air bath. Good black silks yield little or nothing to boiling with water; if the silk has been treated with chloride of zinc or chloride of magnesium or glycerine, these will be dissolved off, and will be found in the residue after evaporating off the water. Chloride of zinc and magnesium can be detected by the usual tests, glycerine by the residue being viscid and sweet as well as by its giving the characteristic tests for those bodies. Occasionally glue is used in finishing silks, this also will be found in the residue and can be detected by its being precipitated from its aqueous solution by alcohol and the odour on ignition of the water residue.

3rd. *Treatment with Petroleum Ether.*—This consists in placing the silk (dry) in a stoppered bottle pouring over it some petroleum ether (this is the light portion of benzoline that distills below 100° C.) shaking well, allowing to stand about half-an-hour, pouring off the ether into a beaker, and evaporating it off in a water bath. For more accurate results it is best to use a Soxhlett fat extraction apparatus, a description of which will be found in most works on oils. If any paraffine wax or waxy material of any sort has been

used in the finishing of the silk these will be extracted by the ether and will be left behind on evaporating this off. The waxy residue may be examined as follows:—treat with hot alcohol, if it dissolves and on cooling deposits crystals, this indicates bees wax; if it does not dissolve, probably paraffin wax or some fatty body may be present; separate out this from the alcohol and boil with a weak acoholic solution of caustic soda; if fat it will be dissolved, if paraffin wax it will be left insoluble. In this way a rough test of these finishing agents may be made. Space does not permit of entering into further details.

4th. *Hydrochloric Acid Treatment.*—Testing black silks with hydrochloric acid enables us to ascertain with what materials the silk has been dyed. The best method of applying this test is to use pure hydrochloric acid diluted with twice its volume of water; in a little of this a swatch of the silk is boiled for a quarter of an hour; the acid will either change it more or less or will not affect it; the acid is used of such a strength that it will not attack the silk fibre in any way. The dye on the silk will be affected as follows:

1st. The fibre becomes discoloured or at most has a faint yellow tinge. The acid liquor has a blackish brown tint; adding lime water does not turn it violet.

The black on the silk is a tannin black, and has been produced by working in alternate baths of tannin products, catechu, cutch, sumac, valonias, etc., and iron salts. The acid dissolves off the black tannate of iron, although sometimes a little tannin may be left in the silk, tinting it slightly; that iron is present in

the acid liquor is easily ascertained by applying the ferrocyanide of potassium test.

2nd. The fibre is discoloured as in the first case, the acid has a bright rose tint, and on adding lime water it turns violet.

The black silk has in this case been dyed with logwood, although probably tannin has also been used in conjunction with it.

3rd. The fibre remains of a dark green or bluish green tint, the acid liquor has a yellowish colour, and is not tinted violet on addition of lime water.

In this case the silk has been dyed with a tannin black on a prussian blue ground, or topped with prussian blue.

4th. The fibre remains of a dark green or bluish green tint, the acid liquor has a rose colour, and is coloured violet on adding lime water.

In this case the silk has been dyed with a logwood black on a prussian blue bottom. If in these two last cases the silk, after being taken out of the acid, is boiled with a little weak caustic soda, the greenish colour changes to red owing to the decomposition of the prussian blue and the deposition of oxide of iron on the fibre. If the alkaline solution be neutralized by the addition of acid and a little ferric chloride added, the formation of a blue precipitate will confirm the presence of prussian blue.

5th. The black is not affected. This class includes blacks dyed with coal tar colours, Aniline, Alizarine, Napthol and Wool Blacks.

To distinguish these, immerse swatches of the silk in a mixture of tin crystals and hydrochloric acid for

a short time. Aniline black and Alizarine black remain unaltered; Napthol black is changed to a reddish brown colour, Wool black to a yellow brown colour; Aniline black is turned green on immersing in sulphurous acid; while Alizarine black is not affected, in both cases chromium will be found in the ash.

In the acid liquor it is advisable to make a preliminary test for iron, lead, tin, and other metals which have been used either as mordants or weighters. Lead is detected by adding sulphuric acid to the solution, when a white precipitate of sulphate of lead will be obtained. Tin is found by filtering off this precipitate of lead, and passing a current of sulphuretted hydrogen through the solution, when a brown precipitate of stannous sulphide or a brownish yellow precipitate of the stannic sulphide will be obtained. Iron is easily tested for by means of ferrocyanide of potassium.

5th. *Treatment with Alkali.*—After the acid treatment the silk is boiled in a weak 1 per cent. solution of caustic soda, for the object of decomposing any prussian blue that may be on the fibre; after boiling in soda the silk is washed, and treated with dilute acid, finally washed, dried and weighed, when the amount of dyeing and weighting material can be estimated.

6th. *Estimation of Ash.*—This is done, first, to ascertain the kind of mordant and weighter used in the dyeing of the silk; second, to indicate the amount. For this purpose about 60 grams of the silk are placed in a porcelain crucible and heated over a Bunsen

burner, until the fibre is burned off and no carbonaceous residue left. The crucible and ash are allowed to cool in a desiccator and weighed. Pure silk goods will leave rather less than 1 per cent. of ash; anything from 1 to 5 per cent. will indicate that the goods have been mordanted; in the case of black silks it would show what might be called a pure black, only enough mordant having been used to properly fix the colouring matter on the fibre. Anything above 5 per cent. may be taken as weighting.

An examination of the residue for the metals it contains may be carried out as follows:

The ash is treated with a mixture of nitric and hydrochloric acids and boiled for some time, when all will be dissolved, or at most only a minute quantity of insoluble matter will be left.

The solution is allowed to cool, when, if any lead be present, crystals of lead chloride will be deposited, a little dilute sulphuric acid is added, and after standing about half-an-hour it is filtered; the precipitate is lead sulphate and chloride, and the usual tests for lead may be applied. The filtrate is boiled free from nitric acid, diluted with water and a current of sulphuretted hydrogen gas passed through; this will precipitate any tin, lead, or copper that may be present as sulphides. Tin as brown stannous or yellow stannic sulphide, lead and copper as black sulphides. The precipitate is filtered off, the filtrate is kept. The precipitate, if black, is boiled with caustic soda, and filtered, to the filtrate is added hydrochloric acid, a brown or yellow precipitate shows the presence of tin. The black residue is next treated with nitric

acid; if it dissolves yielding a blue solution, it is copper, if insoluble it is lead; of course both metals may be present and may be confirmed by other tests. The filtrate from the sulphuretted hydrogen is now boiled to free it from that gas, then a little nitric acid is added and it is further boiled, ammonia in excess is now added, a precipitate is obtained which, if brown, shows the presence of iron, if green, that of chromium; the former metal is confirmed by the prussian blue test, the chromium can be confirmed by boiling for some time with nitric acid and potassium chlorate until a bright yellow solution is obtained, to this ammonia is added, any precipitate is filtered off, and to the filtrate acetic acid and lead acetate is added, a yellow precipitate shows the presence of chromium. For further tests the author's "Course of Qualitative Chemical Analysis" may be consulted.

TESTING DYED SILKS.

Red and other Fancy Colours.—The testing of fancy colours is a matter of great difficulty and requires the exercise on the part of the analyst of patience, keen powers of observation and experience, all of which cannot be gained from written descriptions of tests. The number of colouring matters are numerous, and many are nearly alike in their properties, and further, the sample of silk to be tested may have been dyed with a mixture of several colouring matters, all of which increase the difficulty of testing. The analyist must be prepared to look for very slight colour changes, and to accept these as clues to the main result and work accordingly.

Fancy colours on silk are not often weighted, but the examination for weighting materials will not offer much difficulty, lead, tin, sugar, tartar emetic, tannin may be looked for; the metallic elements are found in the ash of the silk; tannic acid can be detected by immersing the silk in a solution of nitrate of iron, if the silk acquire a grey tint, tannin is present. Sugar can be detected by boiling in water and testing the solution by evaporation and examination of the residue. Its appearance, taste, and odour on heating, serves to distinguish it. Coloured silks can be examined for finishing materials in the same way as black silks.

For detecting the nature of the colouring matters on dyed silks, the following re-agents are required:

Caustic Soda, made by dissolving 1 oz. of the dry re-agent in 10 ozs. of water.

Hydrochloric Acid.—The pure acid as ordinarily bought is diluted with an equal volume of water.

Calcium Hypochlorite.—Half an ounce of bleaching powder dissolved in 10 ozs. of water.

Nitrous Acid.—A quarter of an ounce of sodium nitrite and ¼ oz. of strong sulphuric acid are separately dissolved in 16 ozs. of water; when required for use, equal volumes of the two solutions are mixed together.

Potassium Cyanide.—A solution of 1¼ oz. of the solid re-agent in 20 ozs. of water.

Nitric Acid.—The ordinary commercial acid diluted with an equal volume of water.

Sodium Carbonate.—One oz. of crystal carbonate dissolved in 10 ozs. of water.

The best method of using these re-agents is to place a small quantity of each in white porcelain basins, and enter into them a small swatch of the dyed silk to be tested ; note any change of colour ; heat may be applied if necessary. From the results the character of the dye on the silk may be inferred. Afterwards it is advisable to dye small swatches of the silk with the suspected colour, and submit this to the same tests, and see whether it gives the same results. The following directions have been drawn up as clearly as possible, but the analyst must always exercise some judgment in drawing inferences from whatever results he may get.

RED COLOURS.

1. *Treat a sample with hydrochloric acid:*

a. No action. Roccellin, Magdala red, Orchil.

Treat the silk with caustic soda:

1. It turns somewhat brown. Rocellin.
2. Becomes violet red. Treat with nitric acid, Magdala red turns brownish red, Orchil substitute reddish violet.
3. The silk becomes violet, and is bleached by nitrous acid. Orchil.

b. The silk becomes bluish violet. Congo red, Safranine.

Treat the silk with caustic soda after taking it out of the acid:

1. The silk becomes scarlet, and calcium hypochlorite has no action. Congo red.
2. The silk becomes violet red, and calcium hypochlorite decolourizes it. Safranine.

c. The silk turns reddish violet. Magenta, Acid magenta, Benzopurpurine, Ammoniacal cochineal.

Treat the silk with caustic soda :

1. The silk is rapidly decolourized. Magenta.
2. The silk is slowly decolourized, retains a rose tint, and on washing with water turns red. Acid magenta.
3. No action. Benzopurpurine.
4. The silk becomes lilac. Ammoniacal cochineal.

d. The silk becomes a bright yellow. Eosines, Cochineal, Alizarine.

Treat with caustic soda :

1. The silk becomes decolourized, the soda solution is turned a brownish red. Safrosine.
2. The silk is coloured a violet red ; treat with calcium hypochlorite.
   - I. The silk becomes first violet, then slowly loses colour. Cochineal.
   - II. No action. Treat with sodium carbonate.
     - A. The solution becomes violet. Alizarine.
     - B. The solution becomes pale violet. Erythrosine.
     - C. No action. On boiling the silk in methylated spirits the colouring matter is removed from the silk, and the solution has a strong fluorescence. Eosine.

e. The silk becomes brownish yellow. Scarlet, Peonine, Red woods.

Treat with caustic soda :

1. No action. Treat with nitrous acid.
   I. No action. Scarlet for silk.
   II. Turns pale. Peonine.
2. The silk becomes dark brown. Scarlet.
3. The silk becomes scarlet, and nitrous acid slowly colours it yellow. Red woods.

f. The silk is decolourized. Primrose, Rose bengale. Murexide.

Treat the silk with caustic soda :

1. The silk becomes grey. Murexide.
2. The colour is turned reddish violet. Treat the silk with nitric acid.
   I. It is decolourized. Primrose.
   II. Turned cream coloured. Rose bengale.

Yellow Colours.

Treat a skein of the silk with hydrochloric acid :

a. No action. The silk has been dyed with Saffron, Quinoline yellow, Fustic, Quercitron, Alizarine orange, Phosphine, Chrysoidine.

Treat the silk with water after taking out of the acid :

1. The colour is bleached, and calcium hypochlorite has no action. Quercitron mordanted with alumina.
2. The colour is slightly bleached, but remains of a more or less yellow tint ; cal-

cium hypochlorite turns the silk a brownish yellow. Weld mordanted with alumina. Alumina will be found in the ash of all colours in which it has been used as a mordant.

3. No action; *treat the silk with caustic soda.*
   - A. No action; treat the silk with nitric acid.
     - I. It becomes, first, a greenish-yellow, then turns a dirty green; on washing, the green slowly disappears, and the silk acquires a faint yellow tint. Saffron.
     - II. The silk turns brownish but becomes yellow on washing. Quinoline yellow.
   - B. The shade is only slightly altered.
     - I. The alkaline liquid is coloured yellow, nitric acid turns it a faint yellowish colour. Quercitron mordanted with tin.
     - II. The alkaline liquid is coloured yellow and has a faint green fluorescence. Fustic mordanted with tin or alumina.
   - C. The silk becomes brownish-yellow on treating with calcium hypochlorite.
     - I. The silk becomes brown; nitric acid makes the colour paler. Sumac mordanted with alumina.
     - II. No action. Barberry, Persian berry.

III. Becomes brown; nitric acid darkens it to a chestnut brown. Alkanet.

D. Reddened. Calcium hypochlorite has no action. Heliochrysin.

E. Turns red and darkens considerably; the colour is restored on washing; nitric acid turns it more yellow. Alizarine orange.

F. The colour turns yellow; calcium hypochlorite bleaches it slowly. Chrysoidine.

b. Decolourizes or bleaches considerably. The silk has been dyed with Chrome yellow, Auramine, Flavine, Aurantia, Picric acid, Napthol yellow S, Chrysamine.

Treat a portion of the silk with caustic soda:

1. It becomes scarlet. Chrysamine.
2. It becomes redder. Aurantia.
3. It becomes decolourized. Wash the decolourized silk with water.

   I. The colour does not return. Chrome yellow.

   II. The colour is restored. Heat with sodium carbonate.

   A. Has no action. Auramine.

   B. Decolourizes it. Flavine.
4. The colour of the silk changes slowly to an orange. Heat with potassium cyanide.

   I. Has no action. Napthol yellow S.

   II. Turns red. Picric acid.

c. The silk becomes intensely red, the acid is

coloured violet red; washing restores the colour. Orange IV.

d. The silk becomes reddish-brown. Turmeric, Young fustic.

Treat the silk with caustic soda:

1. It turns reddish-brown; nitrous acid has no action. Turmeric.
2. The alkaline solution is coloured orange; nitrous acid turns it brown. Young fustic.

e. The silk takes a dark colour. On washing, it becomes a brownish-yellow, turns chestnut brown with caustic soda, and orange with calcium hypochlorite. Alkanet mordanted with alumina.

f. The silk becomes reddish, caustic soda turns it a chestnut brown; calcium hypochlorite and nitrous acid have no action. Citronin.

g. The silk becomes orange. Chrysoin, Aniline yellow.

Treat with caustic soda:

1. The colour becomes a faint brown, calcium hypochlorite turns it slightly red. Aniline yellow.
2. The silk is turned scarlet; nitrous acid turns it reddish brown; calcium hypochlorite a faint yellow tint. Chrysoin.

Orange Colours.

Treat a skein of silk with hydrochloric acid:

a. The silk becomes scarlet. Orange I. and II.

b. The silk becomes brownish-red, caustic soda turns it yellow. Orange III.

c. The acid has no action; treat with caustic soda.

I. The colour is not changed. Annotto.

II. Is reddened, and gradually turns brown; nitrous acid has no action. Alizarine orange.

Violet Dyes.

Treat the silk with hydrochloric acid:

a. The silk turns first blue, then bluish-grey, finally orange; on washing with water the colour is restored. Caustic soda reddens the colour. Methyl violet.

b. The silk turns, first, blue, finally amber coloured; on washing with water the colour is restored. Caustic soda first turns it blue, then decolourizes it. Benzyl violet.

c. The silk is coloured a brownish-red, caustic soda turns it bluer. Nitric acid turns it yellow. Gallein.

d. The acid has no action; caustic soda turns it brown, nitric acid green. Phenyl violet.

Green Colours.

Treat with hydrochloric acid:

a. No action; the ash of the silk contains iron. Resorcin green.

b. The silk becomes grey, while the acid liquor acquires a reddish-brown colour. On washing the grey colour is unaltered. Cærulein.

c. The silk is turned yellow; caustic soda decolourizes it. On heating a skein of the silk to

100° C. for a short time it remains unaltered. Malachite green.

d. The silk is turned yellow. Caustic soda decolourizes it; on heating to 100° C. for a short time it turns violet. Methyl green.

e. The silk becomes greenish yellow. Caustic soda turns it brownish-grey; on washing, the original colour is not restored. Aldehyde green.

Blue Colours.

Treat with hydrochloric acid:

a. No action; treat with caustic soda.

1. The silk turns a dirty green colour, and the alkaline solution is coloured yellow. Indigo carmine.
2. The silk is coloured, first green, gradually loses its colour, becoming a faint red; on washing well, and moistening the silk with a solution of potassium ferrocyanide acidulated with hydrochloric acid it turns blue. Prussian blue.
3. The shade changes to red; on washing the blue colour is restored. Induline.
4. The silk becomes violet red; on washing, the blue colour is restored. Calcium hypochlorite decolourizes it. *Treat with nitric acid.*

    A. The silk is turned bluish-grey. Spirit blue.

    B. The silk becomes faint lilac. Alkali blue.

C. The silk becomes, first, blackish blue, then brown. Water blue.

D. Has no action. Azo-blue, Benzo-azurine.

5. Caustic soda has no action. Treat with calcium hypochlorite.

A. The silk slowly becomes grey, and nitric acid turns it a reddish-grey. Basle blue.

B. No action; with nitric acid and nitrous acid the silk is turned green. Methylene blue.

C. Slowly decolourizes the silk. With nitric acid the silk is first turned green, then becomes cream-coloured. Indigo.

b. The acid turns the silk a yellow brown, washing with water turns it first green, then greenish-blue. Indophenol blue.

c. The acid turns the silk reddish-brown, washing with water restores the colour. Alizarine blue.

d. The acid turns the silk scarlet, washing with water first turns it violet, then blue. Resorcin blue.

e. The acid turns the silk green; on washing with water the blue is restored. Victoria blue.

APPENDIX

Of Recipes and Patterns Illustrative of the Preceding Part.

THE recipes are both original and selected. Care has been taken to give none but what are really practical, and upon the results of which confidence can be placed.

All the quantities given are calculated for 10 lbs. silk.

1. Black on silk.*

1. Mordant in a cold bath of nitrate of iron 50° Tw. and wash (see p. 36).

2. Soap with $\frac{1}{2}$ lb. soap at 180-190° F.

3. Dye blue with 2 lbs. yellow prussiate of potash and 2 lbs. of hydrochloric acid.

4. Mordant in nitrate of iron 50° Tw. and wash.

5. Catechu bath, 4 lbs. catechu working at 130-160° F.

6. Mordant in cold alum liquor 8° Tw. and wash.

7. Dye with 1 lb. logwood extract at 51° Tw. and 2 ozs. fustic extract 51° Tw.

8. Brighten with olive oil and acetic acid. See p. 41 for further details.

2. Raven black on silk.*

Prepare the dyebath with—

18 ozs. Anthracite black B (L. Cassella and Co.).
3 ozs. sulphuric acid.
Soap.

Dye at the boil.

3. Black on silk.*

Prepare the dyebath with—

$10\frac{1}{2}$ ozs. Naphthylamine black D (L. Cassella and Co.).
$1\frac{1}{2}$ oz. Indian yellow C (L. Cassella and Co.).
15 ozs. acetic acid.

Dye at the boil to shade.

4. Black on silk.*

Prepare the dyebath with—

3 lbs. Jet black G (F. Bayer and Co.).
1 lb. salt.

Dye boiling for one hour.

* The asterisk denotes that a coloured pattern is given among the illustrative plates.

5. Black on silk.*

Prepare the dyebath with—

1 lb. Diamond green (F. Bayer and Co.).

1 lb. Glauber's salt.

Dye at the boil until the shade is obtained.

6. Cochineal Crimson.*

Prepare a bath with 3 pints of tin perchloride, heat to 110° F., enter the silk and work well for three hours; lift and wring.

Prepare a dyebath with 2 lbs. of cochineal, enter the prepared silk in the cold, work for one hour, then slowly heat to boil and work for one hour; lift, wash, and dry.

7. Bright crimson on silk.*

Prepare the dyebath with—

1½ oz. Violamine A 2 R (Meister, Lucius, and Bruning).

1 oz. sulphuric acid.

Soap-bath.

Working at the boil to shade.

8. Crimson on silk.

Prepare the dyebath with—

½ lb. soap.

2 ozs. Hoffmann violet R.

Dye at the boil, brighten with acetic acid.

9. Cardinal on silk.

The dyebath is made with—

¾ oz. Phosphine.

½ oz. Safranine.

2 ozs. soap.

Dye at 130-150° F., then rinse.

10. Crimson on silk.*

Prepare the dyebath with—

$7\frac{1}{2}$ ozs. Azo-rubine S (Actien. Anilin. Fabrik. Berlin).
3 ozs. sulphuric acid.
Boiled-off liquor.

Enter the silk at 120° F., raise to boil, and work to shade. Rinse and brighten with acetic acid.

11. Bordeaux red on silk.

Prepare the dyebath with—

6 ozs. sulphuric acid.
4 ozs. Acid magenta.
3 ozs. Fast red.
1 oz. Indigo carmine.

Enter at a hand heat, then raise to the boil.

12. Bright bordeaux on silk.

The dyebath is prepared with—

6 ozs. sulphuric acid.
$1\frac{1}{2}$ oz. Glauber's salt.
3 ozs. Bordeaux B.
3 ozs. Fast red.
7 ozs. Acid violet 6 B.

Enter the silk at about 150° F., then raise to the boil and work for half-an-hour.

13. Dark crimson on silk.*

Prepare the dyebath with—

$7\frac{1}{2}$ ozs. Bordeaux S. (Actien. Anilin. Fabrik. Berlin).
2 ozs. sulphuric acid.
Boiled-off liquor.

Enter the silk at 120° F., raise to the boil, and work to shade. Rinse and brighten with acetic acid.

14. Rose scarlet on silk.*

Prepare the dyebath with—

$4\frac{1}{2}$ ozs. Brilliant croceine M O O (L. Cassella and Co.).
2 ozs. sulphuric acid.
Soap.

Dye at the boil to shade.

15. Scarlet on silk.*

Prepare the dyebath with—

6 ozs. Crystal scarlet 6 R (L. Cassella and Co.).
2 ozs. sulphuric acid.
Soap.

Dye at the boil to shade.

16. Scarlet on silk.*

Prepare the dyebath with—

$7\frac{1}{2}$ ozs. Ponceau 4 R B (Actien. Anilin. Fabrik. Berlin).
2 ozs. sulphuric acid.
Boiled-off liquor.

Enter the silk at 120° F., raise to boil, and work to shade. Rinse and brighten with acetic acid.

17. Scarlet rose on silk.*

Prepare the dyebath with—

$4\frac{1}{2}$ ozs. Biebrich scarlet (Kalle and Co.).
2 ozs. sulphuric acid.
Soap.

Enter the silk cold, raise slowly to the boil during one hour. Rinse and brighten with sulphuric acid.

18. Lilac rose on silk.*

Prepare the dyebath with—

6 ozs. Azo-fuchsine G (F. Bayer and Co.).
6 ozs. sulphuric acid.

Dye at the boil to shade.

19. Rose on silk.

Prepare the bath with—

$\frac{1}{4}$ lb. soap.

3 ozs. Rhodamine.

Work the silk in the bath at 160° F. for a short time, then add $\frac{1}{2}$ lb. acetic acid.

Work at the boil to shade.

20. Deep rose on silk.*

Prepare the dyebath with—

$7\frac{1}{2}$ ozs. Erythrosine D (L. Cassella and Co.).

2 ozs. acetic acid.

Soap.

Dye at the boil.

21. Deep rose on silk.*

Prepare the dyebath with—

$4\frac{1}{2}$ ozs. Croceine scarlet 7 B (Kalle and Co.).

2 ozs. sulphuric acid.

Soap.

Enter the silk cold, raise slowly to the boil during one hour. Rinse and brighten with sulphuric acid

22. Rose on silk.

Prepare the dyebath with—

$\frac{1}{2}$ lb. sulphuric acid.

7 ozs. Cyclamine.

1 lb. Glauber's salt.

Dye at the boil, revive with sulphuric acid. This is a very brilliant colour.

23. Bright pink on silk.*

Prepare the dyebath with—

$1\frac{1}{2}$ oz. Rhodamine B (Socy. Chem. Ind. Basle),
1 oz. sulphuric acid.

Dye at 180° F. to shade.

24. Heliotrope on schappe.

Prepare a plain acid bath, or a broken old soap-bath with—

$\frac{1}{2}$ oz. Acid magenta.
$1\frac{1}{2}$ dram Brilliant green.
3 ozs. Archil carmine.

Dye at boil, wash well, and revive with acetic acid.

25. Heliotrope on silk.

Mordant the silk with alum and hyposulphite of soda in the usual way, then run through silicate of soda. Dye with—

$\frac{3}{4}$ lb. Alizarine blue shade.
$\frac{1}{2}$ lb. soap.
$1\frac{1}{2}$ oz. acetic acid.

As described on page 78. Brighten with acetic acid.

26. Heliotrope on silk.

Prepare the dyebath with—

5 ozs. sulphuric acid.
$\frac{3}{4}$ oz. Acid violet 6 B.
$\frac{3}{4}$ oz. Acid violet R.

Dye at the boil.

27. Terra-cotta red on silk.*

Prepare the dyebath with—

3 ozs. Titan brown R (Read Holliday and Sons).

Dissolve the colour in a small quantity of carbonate of soda. Add $\frac{1}{2}$ oz. acetic acid to the bath, and work at the boil until it is exhausted.

28. Maroon on silk.

The dyebath is made with—

2 lbs. Archil.
2 lbs. Fustic extract.
1 lb. tin crystals.

Dye at boil.

29. Prune on silk.

The bath is prepared with—

5 ozs. sulphuric acid.
$\frac{3}{4}$ oz. Fast red.
3 ozs. Acid violet 6 B.

Dye at the boil.

30. Salmon on silk.

Prepare the bath with—

1 oz. soap.
$\frac{1}{16}$ oz. Phosphine.
$\frac{1}{8}$ oz. Safranine.

Working at 100° F. to shade, rinse, and brighten with acetic acid.

31. Alizarine crimson.*

Prepare a bath with $4\frac{1}{2}$ lbs. alum, $7\frac{1}{2}$ ozs. soda crystals, and $7\frac{1}{2}$ gallons water, work in this well for 20 minutes, then allow to steep all night. Wring out.

Prepare the dyebath with 2 lbs. Alizarine, 1 lb. soap, and 1 oz. acetic acid; enter the silk in the cold, work well for

half-an-hour; then slowly raise to the boil and heat until the colour is fully developed; lift, rinse, enter into a hot soap-bath, containing 2 ozs. soap to 6 gallons water; treat for half-an-hour; lift, rinse, and brighten by running through bath of acetic acid, 3 lbs. acid to 10 gallons water; work for 15 minutes; wring and dry.

32. Alizarine scarlet on silk.

The silk is first boiled off, then entered for 3 hours in a bath of 1 lb. alum and $\frac{1}{2}$ oz. hyposulphite of soda in every quart of water. During the last hour the temperature of the bath is raised to 180° F. After taking out the silk is washed, and dyed in old boiled-off liquor, broken with acetic acid, with

$2\frac{1}{2}$ lbs. Alizarine, yellow shade.

The silk is entered into the bath cold, and worked a few times; then the temperature is raised slowly to the boil, and the dyeing continued for half-an-hour. After washing, the silk is soaped slightly once or twice in a soap liquor of $\frac{1}{2}$ oz. soap to a quart of water. After washing brighten with tartaric acid.

33. Yellow on silk.*

Prepare the dyebath with—

3 ozs. Azo-yellow (Soc. Chem. Ind. Basle).
Soap.

Dye at the boil for 30 minutes, wash, brighten with acetic acid, and dry.

34. Bright yellow on silk.

The dyebath is prepared with—

3 ozs. Napthol yellow S.
$\frac{1}{4}$ oz. Orange G.
$\frac{1}{2}$ lb. sulphuric acid.

Enter the silk at 120° F., raise slowly to boil and work to shade, lift, rinse, and dry.

35. **Yellow on silk.***

Prepare the dyebath with—

$1\frac{1}{2}$ oz. Acid yellow F. Y. (Read Holliday and Sons).

3 ozs. sulphuric acid.

Dye at 180° F. till the bath is exhausted.

36. **Canary yellow on silk.**

The dyebath is made with—

8 ozs. Picric acid.

Working to shade at about 180° F.

37. **Sulphur yellow on silk.**

The dyebath is made with—

8 ozs. soap.

6 drams Thioflavine T.

The dyeing is done at the boil, working to shade; brighten with sulphuric acid.

38. **Yellow on silk.***

Prepare the dyebath with—

3 ozs. Chinoline yellow (Actien. Anilin. Fabrik. Berlin).

1 oz. sulphuric acid.

Boiled-off liquid.

Enter the silk at 120° F., heat to the boil, work to shade, lift, rinse; brighten with acetic acid.

39. **Yellow on silk.***

Prepare the dyebath with—

$4\frac{1}{2}$ ozs. Thioflavine T (L. Cassella and Co.).

2 ozs. acetic acid.

Soap.

Dye at the boil to shade.

40. Orange on silk.

Mordant the silk with alum and hyposulphite of soda in the usual way; run through silicate of soda. Dye with—

$2\frac{1}{2}$ lbs. Alizarine orange.
$\frac{1}{2}$ lb. old boiled-off liquor.
$1\frac{1}{2}$ oz. acetic acid.

As described on p. 78. Brighten with acetic acid.

41. Orange on silk.*

Prepare the bath with—

3 ozs. Mandarin G. extra (Actien. Anilin. Fabrik. Berlin).
2 ozs. sulphuric acid.
Boiled-off liquor.

Enter the silk at 120° F., raise to the boil and work to shade. Rinse and brighten with sulphuric acid.

42. Orange on silk.*

Prepare the dyebath with—

$4\frac{1}{2}$ ozs. Orange R (Socy. Chem. Ind. Basle).
Acetic acid.
Dye at the boil.

43. Pale blue on silk.*

Prepare the dyebath with—

15 ozs. Thiocarmine R paste (L. Cassella and Co.).
2 ozs. sulphuric acid.
Soap.

Dyeing at the boil.

44. Blue on silk.

Prepare the dyebath with—

6 ozs. soap.

2 ozs. sulphuric acid.

1½ oz. Napthol black B.

1½ oz. Soluble blue D S.

Dye at the boil.

45. Blue on silk.*

Prepare the dyebath with—

1½ oz. Pure blue B S I (Soc. Chem. Ind. Basle).

Soap.

Sulphuric acid.

Work at about 150° F. to shade. Wash and brighten with acetic acid.

46. Bright blue on silk.*

Prepare the dyebath with—

3 ozs. Blue F S (L. Cassell and Co.).

2 ozs. sulphuric acid.

Soap.

Dye at the boil to shade.

47. Greenish blue on silk.

Prepare the bath with—

½ lb. Indigo carmine.

1 oz. Azo-yellow.

1 lb. alum.

4 ozs. sulphuric acid.

Dyeing at the boil for a quarter of an hour.

48. Peacock blue on silk.

Prepare a bath with—

$2\frac{1}{2}$ ozs. Alkali blue 6 B.

$3\frac{1}{2}$ ozs. borax.

Treat at 180° F., until well grounded (see p. 92), then enter into a new bath containing—

3 drams Picric acid.

5 ozs. sulphuric acid.

And work until the shade is developed ; wash and dry.

49. Blue on silk.*

Prepare a dyebath with—

3 ozs. Victoria blue B (Soc. Chem. Ind. Basle).

2 ozs. acetic acid.

Work just under the boil, to shade. Brighten if required in acetic acid.

50. Blue on silk.*

Prepare the dyebath with—

$1\frac{1}{2}$ oz. Patent blue super. (Meister, Lucius, and Bruning).

1 oz. sulphuric acid.

Soap-bath.

Dye at the boil to shade.

51. Bright blue on silk.*

Prepare the dyebath with—

$2\frac{1}{4}$ ozs. Bavarian blue D S (Actien. Anilin. Fabrik. Berlin).

2 ozs. sulphuric acid.

Boiled-off liquor.

Enter the silk at 120° F., raise to the boil, and work to shade. Rinse and brighten with acetic acid.

52. Navy blue on silk.

Mordant the silk in the usual way with alum and hyposulphite of soda. Run through silicate of soda. Dye with—

$2\frac{1}{2}$ lbs. Alizarine blue R.
$\frac{1}{2}$ lb. old boiled-off liquor.
$1\frac{1}{2}$ oz. acetic acid.

As described on p. 78. Brighten with acetic acid.

53. Bright blue on silk.

Proceed as above, but use Alizarine G W in the dyebath.

54. Dark blue on silk.*

Prepare the dyebath with—

3 ozs. Fast blue B B (Actien. Anilin. Fabrik. Berlin).
2 ozs. sulphuric acid.
Boiled-off liquor.

Enter the silk at 120° F., heat to the boil, and work to shade. Rinse and brighten with acetic acid.

55. Light navy blue on silk.*

Prepare the dyebath with—

$4\frac{1}{2}$ ozs. Indazine M (L. Cassella and Co.).
2 ozs. sulphuric acid.
Soap.

Dyeing at the boil to shade.

56. Navy blue on silk.*

Prepare the dyebath with—

2 lbs. Benzo-azurine G (F. Bayer and Co.).
$4\frac{1}{2}$ ozs. Alkali blue 7 B (F. Bayer and Co.).
$\frac{1}{2}$ lb. phosphate of soda.
$\frac{1}{2}$ lb. soap.

Dye at the boil for one hour, then run through weak acetic acid.

57. Navy blue on silk.

Prepare a broken soap-bath with—

5 ozs. Indulin.
4 ozs. Blue black.
1 oz. Victoria blue.

Dye at the boil, wash and brighten with sulphuric acid.

58. Deep navy blue on silk.*

Prepare the dyebath with—

$7\frac{1}{2}$ ozs. Napthol black 6 B (L. Cassella and Co.).
2 ozs. sulphuric acid.
Soap.

Dyeing at the boil to shade.

59. Dark navy blue on silk.*

Prepare the dyebath with—

1 lb. Benzo-azurine G (F. Bayer and Co.).
$\frac{1}{2}$ lb. phosphate of soda.
$\frac{1}{2}$ lb. soap.

Heat the bath to the boil, turn off the steam, enter the silk, and work for one hour.

60. Alizarine blue on silk.

After boiling off, mordant the silk by first steeping it in a bath of—

Chloride of chrome at 32° Tw.

for 15 to 18 hours, then wring, and run through—

Silicate of soda at 2° Tw.

Wash and dye in an old boiled-off liquor bath, broken with acetic acid, and containing—

$1\frac{1}{2}$ lb. Alizarine blue S.

Work as described under alizarine scarlet, p. 78.

61. Deep sea green on silk.*

Prepare the dyebath with—

3 ozs. New acid green 3 B (Soc. Chem. Ind., Basle).
2 ozs. sulphuric acid.

Work at the boil for half-an-hour.

62. Deep green on silk.

Mordant the silk with alum and hyposulphite of soda, run through silicate of soda. Dye with—

2½ lbs. Anthracene green.
½ lb. old boiled-off liquor.
1½ oz. acetic acid.

As described on p. 78. Brighten with acetic acid.

63. Deep olive on silk.

Mordant the silk by steeping in nitrate of iron 33° Tw. over night rinse well, and dye with—

2½ lbs. Anthracene green.
½ lb. old boiled-off liquor.
1½ oz. acetic acid.

As described on p. 78. Brighten with acetic acid.

64. Deep green on silk.*

Prepare the dyebath with—

6 ozs. Fast green bluish (F. Bayer and Co.).
4 ozs. sulphuric acid.

Dye at the boil to shade.

65. Deep green on silk.

Mordant the silk by steeping over night in nitrate of iron, 33° Tw.

Rinse and dye with—

2 lbs. Gambine Y.
$\frac{1}{4}$ lb. soap.
$1\frac{1}{2}$ oz. acetic acid.

Enter the silk into the bath at a hand heat, work for a short time, then slowly raise to the boil, work for half-an-hour, then lift, wash and brighten in acetic acid.

66. Green on silk.

Dye in a plain soap-bath with—

8 ozs. Methyl green,
2 ozs. Picric acid.

At the boil; revive with sulphuric acid.

67. Sage green on silk.

Prepare the bath with—

5 lbs. alum.
3 lbs. Turmeric.
5 ozs. Cudbear.

Dye at the boil; revive with acetic acid.

68. Bottle green on silk.

The dyeing is done with—

2 lbs. sulphuric acid.
5 lbs. Turmeric.
10 ozs. Cudbear.
2 lbs. Indigo extract.

At the boil.

69. Olive green on silk.

The dyebath is made with—

2 lbs. sulphuric acid.
5 lbs. Turmeric.
8 ozs. Cudbear.
6 ozs. Indigo extract.

Dye at the boil.

70. Olive green on silk.

First dye a blue with—

5 ozs. Induline.
2 lbs. sulphuric acid.

At the boil, then wash and dye in a fresh bath with—

5 ozs. Bismark brown.

Dye at the boil and revive with sulphuric acid.

71. Dark olive green on silk.

Dye a deep blue with—

1 lb. Induline.
2 lbs. sulphuric acid.

At the boil; then wash and dye in a fresh bath with—

8 ozs. Bismark brown.

At the boil, brightening with sulphuric acid.

72. Deep green on silk.

First dye a blue with—

8 ozs. Induline.
2 lbs. sulphuric acid.

After washing, work the silk in a new bath with—

2 lbs. alum.
2 lbs. Fustic extract.

At the boil, afterwards brightening with sulphuric acid.

73. Green on silk.

Mordant the silk by steeping for 12 hours in a bath of—

6 lbs. alum.

Then dye with decoction of—

20 lbs. Fustic.

At 120° F., for half-an-hour, lift, add indigo extract, and work to shade.

By afterwards soddening with copperas, olive greens are obtained. Shading with logwood will give very deep greens.

74. Pale sea green on silk.

Prepare the dyebath with—

1 lb. soap.

8 ozs. sulphuric acid.

$\frac{1}{4}$ oz. Patent blue.

75. Deep green on silk.

Prepare the dyebath with—

6 ozs. soap.

2 ozs. sulphuric acid.

$1\frac{1}{2}$ oz. Napthol black B.

$1\frac{1}{2}$ oz. Napthol green B.

Dye at the boil.

76. Pale green on silk.*

Prepare the dyebath with—

9 ozs. Acid green extra con. (L. Cassella and Co.).

2 ozs. sulphuric acid.

Soap.

Dyeing at the boil.

77. Light green on silk.

Prepare the dyebath with—

5 ozs. sulphuric acid.
2 ozs. Azo-yellow.
$1\frac{1}{2}$ oz. Acid green.

Dyeing at the boil for half-an-hour.

78. Leaf green on silk.

Prepare the dyebath with—

5 ozs. sulphuric acid.
3 ozs. Azo-yellow.
$1\frac{1}{2}$ oz. Acid green.
1 dram Orange G.

Dyeing at the boil for half-an-hour.

79. Green on silk.*

Prepare the dyebath with—

6 ozs. Guinea green B (Actien. Anilin. Fabrik. Berlin).
2 ozs. sulphuric acid.
Boiled-off liquor.

Enter the silk at 120° F., raise slowly to boil, and work to shade. Rinse and brighten with acetic acid.

80. Moss green on silk.

Prepare the dyebath with—

4 ozs. sulphuric acid.
1 lb. alum.
2 lbs. Turmeric.
$1\frac{1}{2}$ oz. Indigo carmine.
$\frac{3}{4}$ oz. Archil extract.

Enter warm and raise to boil, working for a quarter of an hour.

81. Russian green on silk.

6 ozs. sulphuric acid.
$2\frac{1}{2}$ ozs. Azo-yellow.
3 ozs. Acid green.
$\frac{3}{4}$ oz. Nigrosine.
$\frac{1}{4}$ oz. Orange II.
Dyeing at the boil.

82. Olive green on silk.*

Prepare the dyebath with—
15 ozs. Napthol green B (L. Cassella and Co.).
15 ozs. tartaric acid.
Dyed at the boil to shade.

83. Light claret brown on silk.

Prepare the dye with a decoction of—
20 lbs. Camwood.
2 lbs. sulphuric acid.
3 lbs. argol.
Enter the silk and boil for one hour, then add—
$\frac{1}{2}$ lb. Extract of indigo.
Boil one hour, lift and wash.

84. Dark claret brown on silk.

Prepare the dyebath with a decoction of—
30 lbs. Camwood.
2 lbs. argol.
2 lbs. sulphuric acid.
Work for $1\frac{1}{2}$ hour at the boil, then lift, add—
2 lbs. copperas.
Work half-an-hour longer, wash and dry.

85. Brown on silk.

Prepare the dyebath with—

4 ozs. soap.
2 ozs. sulphuric acid.
$1\frac{1}{2}$ oz. Napthol black B.
$1\frac{1}{2}$ oz. Indian yellow G.

Dyeing at the boil.

86. Claret brown on silk.

Mordant the silk by steeping in nitrate of iron 33° Tw over night. Rinse and dye with—

$2\frac{1}{2}$ lbs. Alizarine orange.
$\frac{1}{2}$ lb. old boiled-off liquor.
$1\frac{1}{2}$ oz. acetic acid.

As described on p. 78. Brighten with acetic acid.

87. Seal brown on silk.

Prepare the dyebath with—

1 lb. Mikado brown M.
$\frac{1}{4}$ lb. acetic acid.

Dyeing at the boil to shade.

88. Cinnamon brown on silk.

Prepare the dyebath with—

5 ozs. sulphuric acid.
$1\frac{1}{2}$ oz. Azo-yellow.
$\frac{3}{4}$ oz. Fast brown.
1 oz. Indigo carmine.

Enter at a hand heat, gradually raise to the boil, and work to shade.

89. Gold brown on silk.

Prepare either a simple sulphuric acid bath, or a broken old soap-bath, containing—

$\frac{1}{2}$ lb. Azo-flavine RS.
5 ozs. Fast red E.
3 ozs. Patent blue.

Work at the boil, and revive with sulphuric acid.

90. Gold brown on silk.

Prepare the dyebath with—

4 ozs. sulphuric acid.
1 lb. Glauber's salt.
$2\frac{1}{2}$ ozs. Indian yellow.
2 ozs. Azo-fuchsine G.
$\frac{1}{2}$ oz. Fast green extra.

Dye at the boil.

91. Chestnut brown on silk.

Mordant the silk with alum and hyposulphite of soda in the usual way, then run through silicate of soda. Dye with—

$2\frac{1}{2}$ lbs. Anthracene brown.
$\frac{1}{2}$ lb. old boiled-off liquor.
$1\frac{1}{2}$ oz. acetic acid.

As described on p. 78. Brighten with acetic acid.

92. Deep seal brown on silk.

Mordant by steeping the silk in nitrate of iron 33° Tw. over night, then rinse and dye with—

$2\frac{1}{2}$ lbs. Anthracene brown.
$\frac{1}{2}$ lb. old boiled-off liquor.
$1\frac{1}{2}$ oz. acetic acid.

As described on p. 78. Brighten with acetic acid.

93. Lavender grey on silk.*

Prepare the dyebath with—

3 ozs. Sterosine grey (Read Holliday and Sons).
3 ozs. acetic acid.
Dye at the boil to shade.

94. Drab on silk.

The dyebath is made with—

1 lb. sulphuric acid.
1 oz. Orange G.
1 oz. Indigo extract.

Dye at the boil to shade.

95. Silver grey on silk.

Mordant with—

½ lb. tannic acid.

At 100° F. for 2 hours, then work in nitrate of iron at 2° Tw. for about half-an-hour. Lift, wash, and brighten with weak acetic acid. By afterwards dyeing with 5 ozs. cudbear, a reddish grey is obtained, while a more yellowish tone is obtained by dyeing with 2 lbs. fustic extract, and 8 ozs. copper sulphate.

96. Silver grey on silk.

The dyebath is prepared with—

2 ozs. sulphuric acid.
8 ozs. Glauber's salt.
½ oz. Azo-fuchsine G.
5 drams Fast green extra.
2 drams Indian yellow.

Dyeing at the boil.

97. Dark slate on silk.

Mordant with—

Nitrate of iron 33° Tw.

Allowing the silk to steep over night. Rinse and dye with—

2½ lbs. Alizarine blue R.
¼ lb. soap.
1½ oz. acetic acid.

As described on p. 78. Brighten with acetic acid.

98. Fawn on silk.

Prepare the dyebath with—

4 ozs. Cudbear.
4 ozs. Turmeric.
2 lbs. alum.

Working at the boil to shade.

99. Fawn on silk.

Mordant the silk with alum and hyposulphite of soda in the usual way, then run through silicate of soda. Dye with—

½ lb. Anthracene brown.
½ lb. old boiled-off liquor.
1½ oz. acetic acid.

As described on p. 78. Brighten with acetic acid.

100. Deep violet on silk.*

Prepare the dyebath with—

3 ozs. Violet crystals 5 B O (Soc. Chem. Ind., Basle).
2 ozs. soap.
¼ oz. sulphuric acid.

Dye at about 150° F., then wash and brighten with acetic acid.

101. Red violet on silk.

The dyebath is prepared with—

2 ozs. sulphuric acid.
1 lb. Glauber's salt.
$2\frac{1}{2}$ ozs. Azo-fuchsine G.
$2\frac{1}{2}$ ozs. Acid violet 6 B.

Dyeing at the boil.

102. Violet on silk.

Mordant the silk by steeping for 6 hours in a bath of—

2 lbs. alum.
3 ozs. soda.

Then dye at the boil with—

5 ozs. Cudbear.
1 lb. Logwood.

To shade.

103. Violet on silk.*

Prepare the dyebath with—

3 ozs. Acid violet N (Meister, Lucius and Bruning).
1 oz. sulphuric acid.
Soap-bath.

Work at the boil to shade.

104. Violet on silk.*

Prepare the dyebath with—

6 ozs. Formyl violet S 4 B (L. Cassella and Co.).
2 ozs. sulphuric acid.
Soap.

Dye at the boil.

105. Deep violet on silk.

Mordant the silk by steeping in nitrate of iron 33° Tw. over night, then rinse and dye with—

$2\frac{1}{2}$ lbs. Alizarine blue shade.
$\frac{1}{2}$ lb. old soap liquor.
$1\frac{1}{2}$ oz. acetic acid.

As described on p. 78. Brighten with acetic acid.

106. Deep lavender on silk.*

The dyebath is prepared with—

$\frac{1}{4}$ oz. No. 2 Magenta B (Read Holliday and Sons).
$\frac{1}{4}$ oz. Victoria blue B.
1 lb. Glauber's salt.

Worked at 150° F. to shade.

107. Pale lavender on silk.

Mordant with alum and hyposulphite of soda in the usual way, run through silicate of soda, and dye with—

$\frac{3}{4}$ lb. Alizarine blue G W.
$\frac{1}{2}$ lb. soap.
$1\frac{1}{2}$ oz. acetic acid.

As described on p. 78. Brighten with acetic acid.

108. Lavender on silk.

Prepare the dyebath with—

3 drams Methyl violet R.
2 ozs. soap.

Dye at about 120° to 130° F.

109. Lilac on silk.

Prepare the dyebath with—

3 drams Methyl violet 5 R.
2 ozs. soap.

Dye at about 120° F.

110. Mauve on silk.

Prepare the dyebath with—

6 ozs. soap.

2 ozs. sulphuric acid.

$1\frac{1}{2}$ oz. Naphthol black B.

$1\frac{1}{2}$ oz. Amaranth B.

Dye at the boil.

111. Purple on silk.

Mordant the silk with alum and hyposulphite of soda in the usual way, then run through silicate of soda. Dye with—

2 lbs. Galleine.

$\frac{1}{2}$ lb. old soap liquor.

1 oz. acetic acid.

In the way usual with alizarine colours, see p. 78. Brighten with acetic acid.

112. Scarlet on half-silk.*

Prepare the dyebath with—

9 ozs. Deltapurpurine 5 B (F. Bayer and Co.).

$7\frac{1}{2}$ ozs. phosphate of soda.

$7\frac{1}{2}$ ozs. soap.

Heat the bath to the boil, turn off the steam, enter the goods and work to shade.

113. Pale crimson on half-silk.*

Prepare the dyebath with—

18 ozs. Rose-azurine B (F. Bayer and Co.).

$7\frac{1}{2}$ ozs. phosphate of soda.

$7\frac{1}{2}$ ozs. soap.

Heat the bath to the boil, turn off the steam, enter the goods, and dye for one hour.

114. Scarlet on half-silk.*

Prepare the dyebath with—

27 ozs. Brilliant Congo R (F. Bayer and Co.).
$7\frac{1}{2}$ ozs. phosphate of soda.
$7\frac{1}{2}$ ozs. soap.

Raise the temperature of the bath to the boil, turn off steam, enter the goods, and dye to shade.

115. Orange on half-silk.*

Prepare a dyebath with—

9 ozs. Benzo-orange R (F. Bayer and Co.).
$7\frac{1}{2}$ ozs. phosphate of soda.
$7\frac{1}{2}$ ozs. soap.

Heat to the boil, enter the half-silk fabric, and dye to shade. The heat is stopped as soon as the goods are entered.

116. Canary yellow on half-silk.

Prepare the dyebath with—

$\frac{1}{2}$ lb. of soap.
$\frac{1}{2}$ lb. Thioflavine S.

Dye at the boil. Brighten with acetic acid.

117. Deep canary yellow on half-silk.

Lay down the half-silk in—

$\frac{1}{2}$ lb. tannic acid.

For 5 or 6 hours. Then run through a bath of—

6 ozs. tartar emetic.

Dye in a fresh bath containing—

5 ozs. Thioflavine T.
2 ozs. hydrochloric acid.

At the boil. Wash and dry.

118. Yellow on half-silk.*

Prepare the dyebath with—

3 ozs. Chrysamine G (F. Bayer and Co.).
$7\frac{1}{2}$ ozs. phosphate of soda.
$7\frac{1}{2}$ ozs. soap.

Heat the bath to the boil, turn off steam, and enter the goods. Work for one hour.

119. Navy blue on half-silk.*

Prepare the dyebath with—

2 lbs. Benzo-azurine G (F. Bayer and Co.).
$4\frac{1}{2}$ ozs. Alkali blue 7 B (F. Bayer and Co.).
$\frac{1}{2}$ lb. phosphate of soda.
$\frac{1}{2}$ lb. soap.

Dye at the boil for one hour, lift, run through weak acetic acid.

120. Brown on half-silk.*

Prepare the dyebath with—

14 ozs. Benzo-brown N B (F. Bayer and Co.).
1 lb. salt.

Dye at the boil to shade.

121. Brown on half-silk.

Prepare the dyebath with—

5 ozs. Direct orange R R.
5 ozs. Benzo-azurine G.
4 ozs. soap.
$\frac{1}{2}$ lb. phosphate of soda.

Dye at the boil for one hour, wash, and revive with acetic acid. And shade as required with Safranine, Auramine, Malachite green, and Methylene blue.

122. Bronze green on half-silk

Prepare the dyebath with—

5 ozs. Direct orange R R.

5 ozs. Benzo-azurine G.

4 ozs. soap.

$\frac{1}{2}$ lb. phosphate of soda.

Dye at the boil for one hour, wash and revive with acetic acid, and shade with malachite green, auramine, and chrysoidine to the required tone.

123. Brown and black on half-silk.*

Prepare the dyebath with—

2 lbs. Benzo-black S extra (F. Bayer and Co.).

2 lbs. salt.

Dye at the boil for one hour.

124. Silver grey and drab on half-silk.*

The silk and cotton goods are steeped for 12 hours in a cold solution of—

$\frac{1}{2}$ lb. tannin.

Then taken out, slightly rinsed, and for half-an-hour worked in cold solution of—

2 quarts nitrate of iron 51° Tw.

200 quarts water.

After washing they are taken through a bath for 10 minutes of—

1 oz. bichromate of potash.

50 gallons water.

Then dyed in a cold bath with—

$2\frac{1}{2}$ lbs. logwood.

$4\frac{1}{2}$ ozs. fustic extract 51° Tw.

Wash and in a fresh bath treat with—

$\frac{1}{8}$ oz. of Methyl violet R.

In the cold for 10 minutes.

Soap for 10 minutes in the cold with 1 oz. soap in 6 gallons water.

Wash and brighten with acetic acid 1 in 1,000.

125. Crimson and green on silk-cotton.*

1. Dye the silk in a bath containing—

 2 ozs. Scarlet O O O (Read Holliday and Sons).
 8 ozs. Glauber's salt.
 2 ozs. sulphuric acid.

Enter at 150° F., then heat to the boil and work until bath is exhausted, lift, wring, and rinse.

2. Enter into a cold bath of—

 3 ozs. tannic acid.

Allow to steep for 6 hours or all night, then lift, wring, and fix in a bath of—

 $2\frac{1}{2}$ ozs. tartar emetic.

Wring and rinse.

3. Dye in a bath at from 120° to 130° F. of—

 1 oz. of Crystal green Y (Read Holliday and Sons).

Work for about $1\frac{1}{2}$ to 2 hours, then rinse well; soap in a cold soap-bath of $1\frac{1}{2}$ oz. soap per gallon of water; then brighten in weak acetic acid, wring, and dry.

126. Deep olive and yellow on half-silk.*

Prepare the dyebath with—

 $1\frac{1}{2}$ oz. Acid violet 6 B N (Soc. Chem. Ind., Basle).
 $\frac{1}{2}$ oz. sulphuric acid.
 1 lb. Glauber's salt.

Dye at the boil till the bath is exhausted, lift, wash, and enter into a cold bath containing—

 3 ozs. tannin.

Allow to steep over night; then lift and enter for 15

minutes into a cold bath of 1½ oz. tartar emetic.

Lift, rinse, and dye at 120° F. in a bath of—

1½ oz. Auramine.

Work to shade, lift, wash, and soap in a cold soap-bath, wash, brighten in acetic acid.

127. Dark blue and brown on silk-cotton.*

1. Dye the silk in a bath containing—

1½ oz. Induline B B (Read Holliday and Sons).
5 lbs. Glauber's salt.
1½ oz. sulphuric acid.

Enter the goods at 150° F., and gradually raise to the boil, work the cloth for one hour, then lift and rinse.

2. Prepare a cold bath of—

2 ozs. tannic acid.

Enter the cloth, work for one hour, then allow to steep for 6 hours or all night; lift, rinse, and fix in a cold bath of—

1½ oz. tartar emetic.

3. Dye in a bath of—

1 oz. pure Bismark brown R (Williams Bros. and Co.).

At 100° F. for one hour, lift, rinse, work in a cold soap-bath of 2 ozs. to gallon for half-an-hour, then after rinsing brighten with a weak acetic acid bath.

128. Black on Tussah silk.*

For details of the process, see p. 36, and recipe 1.

129. Aniline black on Tussah silk.*

This was dyed according to the process described on p. 49, direct *black* process.

130. Deep olive brown on Tussah.

Prepare either a plain acid bath, or a broken, boiled-off bath with—

3 ozs. Acid magenta.
$\frac{3}{4}$ oz. Malachite green.
3 ozs. napthol yellow S.

Dye at boil, wash well, revive with sulphuric acid.

131. Green on Tussah silk.*

Prepare the dyebath with—

$\frac{1}{4}$ oz. Green crystals.
$\frac{1}{8}$ oz. Bismark brown.
1 lb. Glauber's salt.

Enter the silk at 180° F., and work to shade.

132. Gold green on Tussah.

Dyebath is prepared with old curdled boiled-off liquor, 3 oz. Napthol yellow S, and $\frac{1}{4}$ ozs. Brilliant green. Work at the boil.

133. Silver grey on Tussah.

Prepare an old soap-bath with sulphuric acid, and—

2 ozs. Victoria blue B.
2 ozs. Rubin extra.

Dye at the boil; revive with acetic acid.

134. Cardinal on Tussah.

Prepare either a simple acid bath, or a broken old soap-bath, containing—

1 lb. Croceine scarlet 3 B.
$\frac{3}{4}$ oz. Acid magenta.
$1\frac{1}{2}$ oz. Orange G.

Work at the boil; revive with sulphuric acid.

135. Cerise on Tussah.

Prepare the dyebath with—

$\frac{1}{2}$ lb. Eosine G G.

$\frac{1}{2}$ lb. soap.

2 ozs. acetic acid.

Dyeing at the boil.

SILK PRINTING.

THICKENINGS.

For ease of reference, the recipes for the thickenings used in printing on silk and silk fabrics given in the body of the book are repeated here.

For hand-printing.

136. 1. 5 lbs. good white starch, and 5 lbs. white dextrine are mixed with 1 gallon of water, $7\frac{1}{2}$ lbs. acetic acid, 12° Tw., 2 lbs. olive oil, and $2\frac{1}{2}$ gallons of water are then added, and the whole boiled into a paste. This will suit all colours used in the steam style of printing.

137. 2. 5 lbs. of good white starch are mixed with 1 gallon of water, and $2\frac{1}{2}$ lbs. of glue previously dissolved in $2\frac{1}{2}$ gallons of water are added, the whole is boiled to a paste. After allowing to cool, 5 lbs. of acetic acid, 7° Tw., and 2 lbs. of olive oil are stirred in.

For roller-printing.

138. 1. 5 lbs. starch of good quality are mixed into a paste with $\frac{1}{2}$ gallon of water; 1 lb. of gum tragacanth, previously dissolved in $1\frac{1}{2}$ gallon of water, are added and well mixed; 5 lbs. acetic acid 12° Tw., 3 lbs. olive oil, and 2 gallons of water are then added; the whole is boiled to a paste. This thickening will suit all colours.

139. 2. Dextrine thickening is made by boiling for half-an-hour 10 lbs. dextrine with 1 gallon of water.

140. 3. Prepare a tragacanth liquor by steeping 1 lb. gum tragacanth in 1 gallon of water for three days, then boil until dissolved; add 20 lbs. dextrine, which has been previously mixed with 4 gallons water; boil for about 15 minutes, then add 2 lbs. of glycerine, and 2 lbs. acetic acid.

141. Olive green.

6 ozs. sulphate of alumina.
3 ozs. oxalic acid.
Dissolved in—
1 lb. water.
Then add—
2 lbs. Cœruleine S.
5 lbs. thickening.

142. Leaf green.

6 ozs. sulphate of alumina.
3 ozs. oxalic acid
Dissolved in—
1 lb. water.
Then add—
1 lb. Cœruleine S.
1 lb. Galloflavine.
$6\frac{1}{2}$ lbs. thickening.

143. Cream.

5 ozs. sulphate of alumina.
$2\frac{1}{2}$ ozs. oxalic acid.
Dissolve in—
1 lb. water.
Then add—
5 ozs. Alizarine yellow.
$6\frac{1}{2}$ lbs. thickening.

144. Brown.

$1\frac{1}{2}$ lb. Anthracene brown.
1 lb. acetate of chrome, 32° Tw.
5 ozs. oxalic acid.
$\frac{1}{2}$ lb. water.
$6\frac{3}{4}$ thickening.

145. Golden yellow.

6 ozs. sulphate of alumina.
3 ozs. oxalic acid.
1 lb. water.
Dissolve and mix with—
$\frac{3}{4}$ lb. Alizarine orange
$\frac{1}{2}$ lb. Galloflavine.
$6\frac{1}{2}$ lbs. thickening.

146. Lemon yellow.

6 ozs. sulphate of alumina.
3 ozs. oxalic acid.
1 lb. water.
Mix, then add—
1 lb. Galloflavine.
$6\frac{3}{4}$ lbs. thickening.

147. Bordeaux.

9 ozs. oxalic acid.
$\frac{1}{2}$ lb. water.
$\frac{3}{4}$ lb. Galleine.
$\frac{1}{4}$ lb. Alizarine.
1 lb. chromium chloride 32° Tw.
$6\frac{1}{2}$ lbs. thickening.

148. Orange.

6 ozs. sulphate of alumina.
3 ozs. oxalic acid.

Dissolved in—

1 lb. water.

Add—

1½ lb. Alizarine orange.
6½ lbs. thickening.

149. Alizarine red on silk.

7 lbs. thickening.
½ lb. water.
6 ozs. sulphate of alumina.
3 ozs. oxalic acid.
9 ozs. water.
1 lb. Alizarine.

150. Scarlet.

3 ozs. Alizarine.
2 ozs. Scarlet R.

Dissolved in—

1 lb. water.
6 ozs. alumina sulphate dissolved in—
1 lb. water.
3 ozs. oxalic acid.
3 ozs. tin perchloride.
6½ lbs. thickening.

151. Black.

1 lb. Naphthol black.
6 lbs. water.
5 lbs. thickening.
½ lb. oxalic acid.
½ lb. alum.
¾ lb. sodium acetate.

Make up to about 15 lbs. printing colour. Print, steam for 2 hours at $7\frac{1}{2}$ lbs. pressure, wash and dry.

Greys and slates may be produced by reducing down this colour.

152. Brown olive.

$\frac{3}{4}$ lb. Cœruleine S.
5 ozs. Alizarine blue S R N.
$\frac{1}{4}$ lb. Galloflavine.
6 ozs. acetate of chrome, 32° Tw.
8 lbs. thickening.

153. Blue.

2 ozs. Alizarine blue S.
4 ozs. acetate of chrome, 32° Tw.
9 lbs. thickening.

154. Navy blue.

$1\frac{1}{2}$ lb. Galleine.
$\frac{3}{4}$ lb. Alizarine blue S.
4 ozs. acetate of chrome, 32° Tw.
$7\frac{1}{2}$ lbs. thickening.

155. Violet.

3 lbs. Galleine.
6 ozs. acetate of chrome, 32° Tw.
$6\frac{3}{4}$ lbs. thickening.

156. Blue violet.

2 lbs. Galleine.
6 ozs. copperas.
3 ozs. oxalic acid, dissolved in—
1 lb. water.
$\frac{1}{2}$ lb. sodium acetate, dissolved in—
$\frac{1}{2}$ lb. water.
$6\frac{1}{2}$ lbs. thickening.

157. Slate.

$\frac{1}{2}$ lb. Alizarine blue S.
6 ozs. Alizarine black S.
1 oz. Cœruleine S.
3 ozs. acetate of chrome, 32° Tw.
3 ozs. oxalic acid, dissolved in—
$\frac{1}{2}$ lb. water.
$\frac{1}{2}$ lb. sodium acetate, dissolved in—
$\frac{1}{2}$ lb. water.
$7\frac{3}{4}$ lbs. thickening.

158. Grey.

$\frac{1}{2}$ lb. Alizarine black S.
3 ozs. acetate of chrome, 32° Tw.
9 lbs. thickening.

159. Black.

2 lbs. Alizarine black S.
6 ozs. acetate of chrome, 32° Tw.
$\frac{1}{2}$ lb. Alizarine blue S.
$\frac{1}{2}$ lb. oxalic acid dissolved in—
$\frac{1}{2}$ lb. water.
$\frac{1}{2}$ lb. sodium acetate, dissolved in—
$\frac{1}{2}$ lb. water.
$6\frac{1}{2}$ lbs. thickening.

160. Olive yellow.

$\frac{3}{4}$ lb. Cœruleine S.
$\frac{1}{2}$ lb. Galloflavine.
$\frac{3}{4}$ lb. water.

Mix into paste, then add—

5 ozs. oxalic acid.
6 ozs. acetate of chrome, 32° Tw.
1 oz. tin oxide paste.
$7\frac{1}{4}$ lbs. thickening.

161. Yellow.

1 lb. Alizarine yellow.
4 ozs. acetate of chrome, 32° Tw.
9 lbs. thickening.

162. Dark blue on silk.* (Standard colour.)

Prepare the printing colour with—
8 ozs. Gallanilic indigo P S (Durand, Huguenin and Co.).
$6\frac{1}{4}$ gallons senegal gum thickening.

Print, steam for one hour without pressure, wash, soap lightly for 10 minutes, rinse, and brighten with acetic acid.

163. Pale blue on silk.*

Prepare the printing colour with—
1 pint standard blue.
2 pints gum thickening.

Print and work as pattern, No. 162.

164. Turquoise blue on silk.*

Prepare the printing colour with—
2 pints standard blue.
1 pint malachite green liquor.

Print and work as pattern, No. 162.

The malachite green liquor is made with—
$\frac{1}{2}$ oz. malachite green.
62 ozs. gum senegal thickening.

165. Heliotrope on silk.*

Prepare the printing colour with—

5 pints standard blue.
6 ozs. Giroflée D H in powder (Durand, Huguenin and Co.).

Print and work as pattern, No. 166.

166. Brown on silk.*

Prepare the printing colour with—

5 pints standard blue.
4½ ozs. Orange 2.

Print and work as pattern, No. 166.

167. Magenta.

3 lbs. thickening.
1 oz. Magenta.
1½ oz. acetic acid.
3 lbs. water.
1 lb. water.

168. Brilliant green.

2 lbs. thickening.
1 oz. Green.
1½ oz. acetic acid.
3 ozs. tartaric acid.
2 lbs. water.

169. Bismark brown.

2½ lbs. thickening.
2 ozs. Brown.
2½ lbs. water.
6 ozs. sodium phosphate.
3 ozs. acetic acid.

170. Olive green.

Mix—

1 lb. Cœruleine S.

1 lb. of water.

Into a paste, add—

6 ozs. chromium chloride, 32° Tw.

4 ozs. oxalic acid.

$6\frac{3}{4}$ lbs. thickening.

All the recipes for printing given above are for the so-called steam style of printing described on page 119, *et seq.* The Pigment style is little used, for reasons previously pointed out, but the following recipes are given as guides in working—

171. Ultramarine blue.

7 pints water.

3 lbs. lactarine.

Stir up well and add—

5 ozs. ammonia ·880.

10 ozs. caustic soda, 32° Tw.

6 lbs. ultramarine.

$2\frac{1}{2}$ pints water.

Mix into paste, then mix with other ingredients.

172. Ultramarine blue.

2 lbs. ultramarine.

1 pint water.

Grind to paste, then stir in—

1 pint Tragacanth liquor, 1 in 16.

1 quart Albumen solution, 8 in 10.

173. Green.

13 lbs. Guignet's green in paste.

2 gallons Albumen solution, 3 in 10,

174. Grey.

2 lbs. lamp black.
2 gallons Albumen solution, 3 in 10.

By increasing the proportion of black various shades can be obtained.

175. Yellow.

13 lbs. chrome yellow in paste.
2 gallons Albumen solution, 3 in 10.

170. Orange.

13 lbs. chrome orange in paste.
2 gallons Albumen solution, 3 in 10.

177. Scarlet.

10 lbs. scarlet lake in paste.
2 gallons Albumen solution.

178. Pink.

5 lbs. Rhodamine pink lake.
2 gallons Albumen solution.

Many of the coal tar colours can be made into lakes, and thus be used for printing.

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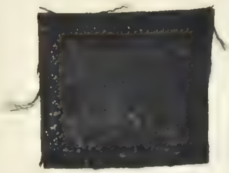
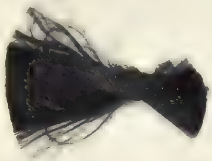
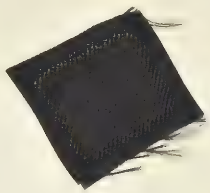


1. BLACK ON SILK.



2. RAVEN BLACK ON SILK.

3. BLACK ON SILK.



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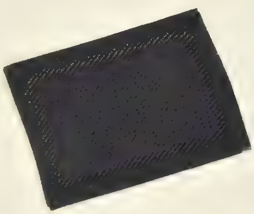

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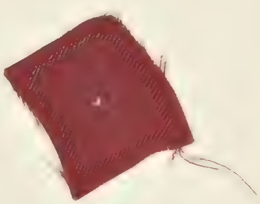
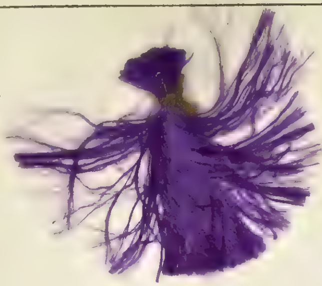
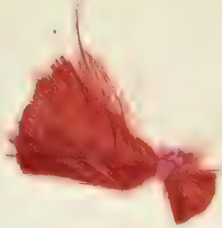


6. COCHINEAL CRIMSON ON SILK.

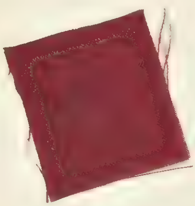
PLATE I.



7. BRIGHT CRIMSON ON SILK.

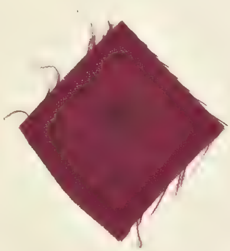


14. ROSE SCARLET ON SILK.



10. CRIMSON ON SILK.

15. SCARLET ON SILK.



13. DARK CRIMSON ON SILK.

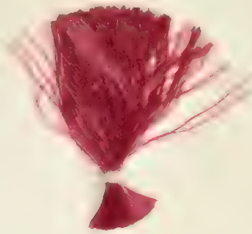
16. SCARLET ON SILK.

PLATE II.

17. SCARLET ROSE ON SILK.

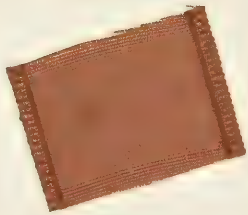
18. LILAC ROSE ON SILK.

20. DEEP ROSE ON SILK.



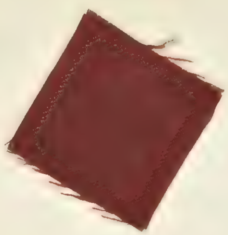
21. DEEP ROSE ON SILK.

23. BRIGHT PINK ON SILK.



27. TERRA-COTTA RED ON SILK.

PLATE III.



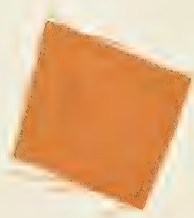
31. ALIZARINE CRIMSON ON SILK.

38. YELLOW ON SILK.

33. YELLOW ON SILK.

39. YELLOW ON SILK.

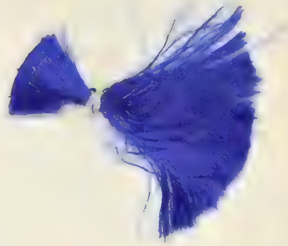
35. YELLOW ON SILK.



41. ORANGE ON SILK.

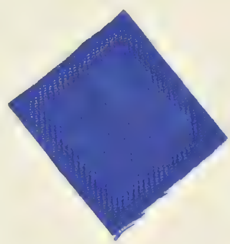
PLATE IV.

42. ORANGE ON SILK.

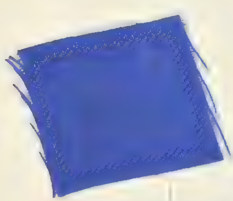


46. BRIGHT BLUE ON SILK.

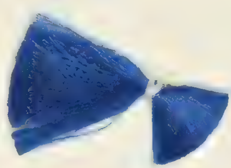
43. PALE BLUE ON SILK.



49. BLUE ON SILK.

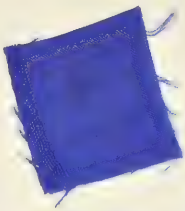


45. BLUE ON SILK.

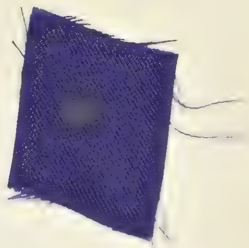


50. BLUE ON SILK.

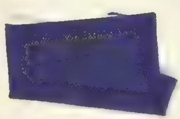
PLATE V.



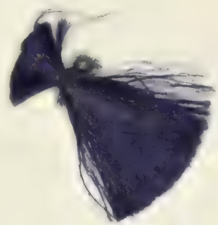
51. BRIGHT BLUE ON SILK.



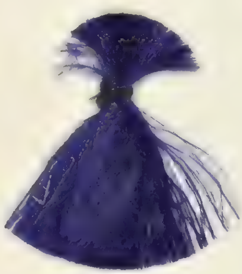
56. NAVY BLUE ON SILK.



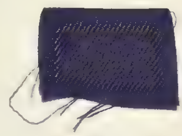
54. DARK BLUE ON SILK.



58. DEEP NAVY BLUE ON SILK.

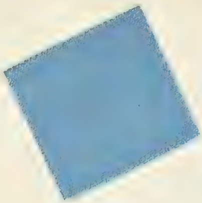


55. LIGHT NAVY BLUE ON SILK.

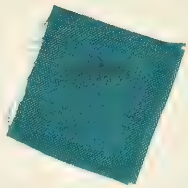


59. DARK NAVY BLUE ON SILK.

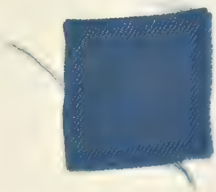
PLATE VI.



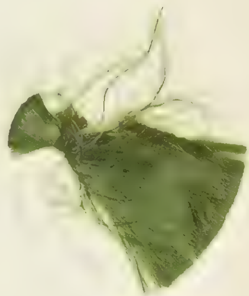
61. DEEP SEA GREEN ON SILK.



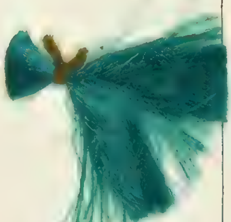
79. GREEN ON SILK.



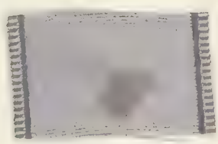
64. DEEP GREEN ON SILK.



82. OLIVE GREEN ON SILK.



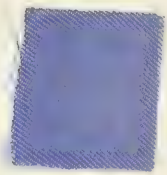
76. PALE GREEN ON SILK.



93. LAVENDER GREY ON SILK.

PLATE VII.

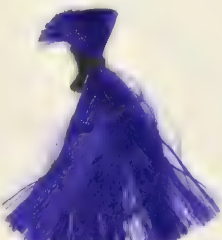
100. DEEP VIOLET ON SILK.



106. DEEP LAVENDER ON SILK.

103. VIOLET ON SILK.

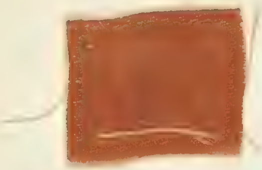
112. SCARLET ON HALF-SILK.



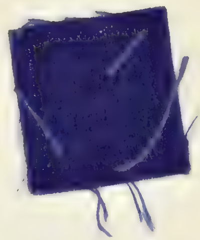
104. VIOLET ON SILK.

113. PALE CRIMSON ON HALF-SILK.

PLATE VIII.

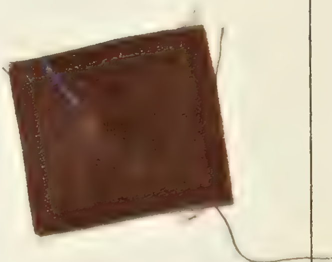


114. SCARLET ON HALF-SILK.



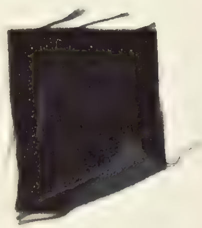
119. NAVY BLUE ON HALF-SILK.

115. ORANGE ON HALF-SILK.



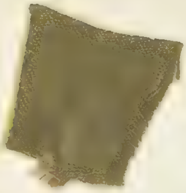
120. BROWN ON HALF-SILK.

118. YELLOW ON HALF-SILK.

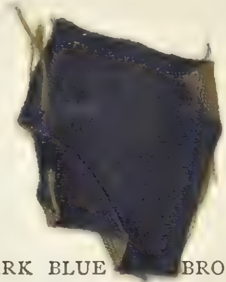


123. BROWN AND BLACK ON HALF-SILK.

PLATE IX.

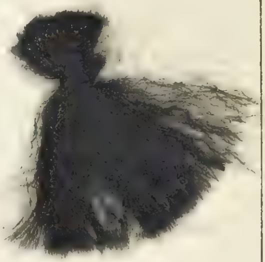


124. SILVER GREY AND DRAB ON HALF-SILK.

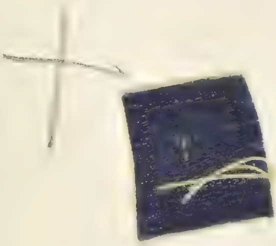


127. DARK BLUE [illegible] BROWN ON SILK-COTTON.

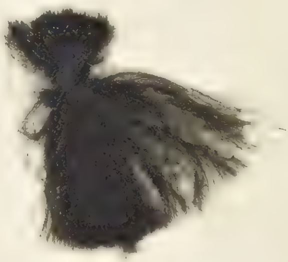
125. CRIMSON AND GREEN ON HALF-SILK.



128. BLACK ON TUSSAH SILK.

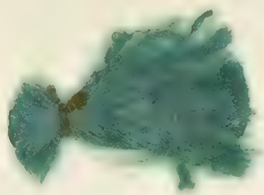


126. DEEP OLIVE AND YELLOW ON HALF-SILK.

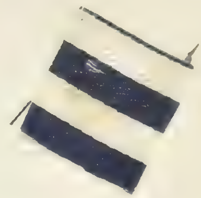


129. ANILINE BLACK ON TUSSAH SILK.

PLATE X.



131. GREEN ON TUSSAH SILK.

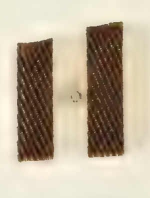


164. TURQUOIS BLUE ON SILK.

162. DARK BLUE ON SILK.

165. HELIOTROPE ON SILK.

163. PALE BLUE ON SILK.



166. BROWN ON SILK.

PLATE XI.

AN

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